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# ENVIRONMENTAL ASSESSMENT

## Geothermal leasing of National Forest System lands in the Glass Mountain Known Geothermal Resource Area

U.S. Department of Agriculture
Forest Service
Pacific Southwest Region
Modoc, Klamath, and Shasta-Trinity National Forests

U.S. Department of the Interior
Bureau of Land Management
California State Office
Susanville District

September 1984

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
CALIFORNIA STATE OFFICE
SUSANVILLE DISTRICT

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
PACIFIC SOUTHWEST REGION
MODOC NATIONAL FOREST

October 2, 1984

Dear Reviewer:

This supplemental environmental assessment addresses the impacts of geothermal development and production on 161,000 acres of the recently expanded Glass Mountain Known Geothermal Resource Area (KGRA), and some adjacent areas considered to have some potential for geothermal resource development.

The previous environmental assessment (U.S. Forest Service 1981) analyzed primarily the impacts of casual use geothermal exploration. This document supplements the 1981 analysis and includes the exploration, development and production phases of the geothermal program. This analysis will help in deciding which lands should be leased and what measures are required to protect valuable resources.

If you have comments on the proposed action or on this document, please sent them to us by November 2, 1984.

Following the 30 day review period, a decision record will be prepared by the Bureau of Land Management taking into consideration all comments received.

Your interest in this project is appreciated.

Sincerely,

C. Rex Cleary
District Manager
Bureau of Land Management
P.O. Box 1090
Susanville, CA 96130

Glenn Bradley
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Modoc National Forest
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# ENVIRONMENTAL ASSESSMENT

## Geothermal Leasing of National Forest System Lands in the

## Glass Mountain Known Geothermal Resource Area

Approved By:

Glenn Bradley — Forest Supervisor, Modoc National Forest — 9/7/84 (Date)

Robert L Rice — Forest Supervisor, Klamath National Forest — 9/7/84 (Date)

William F. Laycock — Forest Supervisor, Shasta-Trinity National Forest — 9/7/84 (Date)

C. Ray Chiarry — District Manger, Susanville District — 9/14/84 (Date)

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# INTRODUCTION

The Geothermal Steam Act of 1970 (PL 90-581) gives the Secretary of the Interior (delegated to the Bureau of Land Management (BLM)) the authority to issue leases for the development and utilization of geothermal steam and associated geothermal resources on Federal lands. The BLM receives lease applications and issues leases. Leases on National Forest lands may be issued ". . . only with the consent of, and subject to such terms and conditions as may be prescribed by the Secretary of the Department of Agriculture to ensure adequate utilization of the lands for the purposes for which they were withdrawn or acquired." Responsibility for giving or withholding consent to the BLM on geothermal lease applications on the Modoc, Klamath, and Shasta-Trinity National Forests rests with the Regional Forester, Pacific Southwest Region, U.S. Forest Service.

The area to be covered by this document includes the recently expanded Glass Mountain KGRA, and some adjacent areas considered to have potential for geothermal resource development. The entire study area encompasses approximately 161,000 acres.

Previous environmental assessments (U.S. Forest Service 1981) analyzed primarily the impacts of casual use geothermal exploration. This document supplements the 1981 analysis and includes exploration, development and production phases of the geothermal program. The analysis will aid in deciding which lands should be leased and what measures are required to protect valuable resources. It will also be the primary reference for assessing noncompetitive leasing adjacent to the study area.

In 1973, the U.S. Department of the Interior (USDI) prepared an environmental impact statement for the national geothermal leasing program. This analysis was reported in a 4-volume issue entitled, "Final Environmental Statement for the Geothermal Leasing Program." This analysis tiers to the USDI analysis, and incorporates Volumes 1 and 2 by reference. Volume 1 describes the activities included in a geothermal development program--and the overall effects that could occur.

Control of operations and mitigation of effects are accomplished by the Federal government through Federal laws and regulations, State laws regarding air and water quality, and special stipulations identified in this analysis and included in the lease. The lessee must file an operating plan for subsequent activities in exploration, development, and operation of the lease. Each operating plan will require an additional environmental analysis and approval. Additional site-specific conditions are then required before the lessee can begin activities.

## PURPOSE OF AND NEED FOR THE PROPOSED ACTION

The purpose of this action is to lease Federal geothermal resources for geothermal development. Although geothermal energy is better known for electrical generation, it is more widely used in direct use applications for space, process, and water heating for residential, commercial, industrial, and agricultural consumers. For the purpose of the analysis, however, we will limit our discussion to electrical power generation, which would have a greater effect upon the natural environment.

With present air quality and other limitations on coal, oil and gas fired electrical generating plants and the moratorium on nuclear power plants in California, geothermal power is one of the few alternatives remaining capable of contributing to the satisfaction of short-term electrical energy demands without creating serious environmental impacts. The potential contribution of this resource to local and regional energy needs is important.

The exploration, development, and use of these geothermal resources was considered and provided for in the Land Management Plan for the Medicine Lake Planning Unit. That Plan, and the final environmental statement, are hereby incorporated by reference.

## ISSUES

During development of the Medicine Lake Land Management Plan and during subsequent environmental assessments the following issues were defined relative to geothermal development:

1. How will wildlife habitat be impacted?
2. How will recreational and visual resources be impacted?
3. How will air and water quality be protected?
4. How will geological features be protected?
5. How will the Lava Beds National Monument be protected?

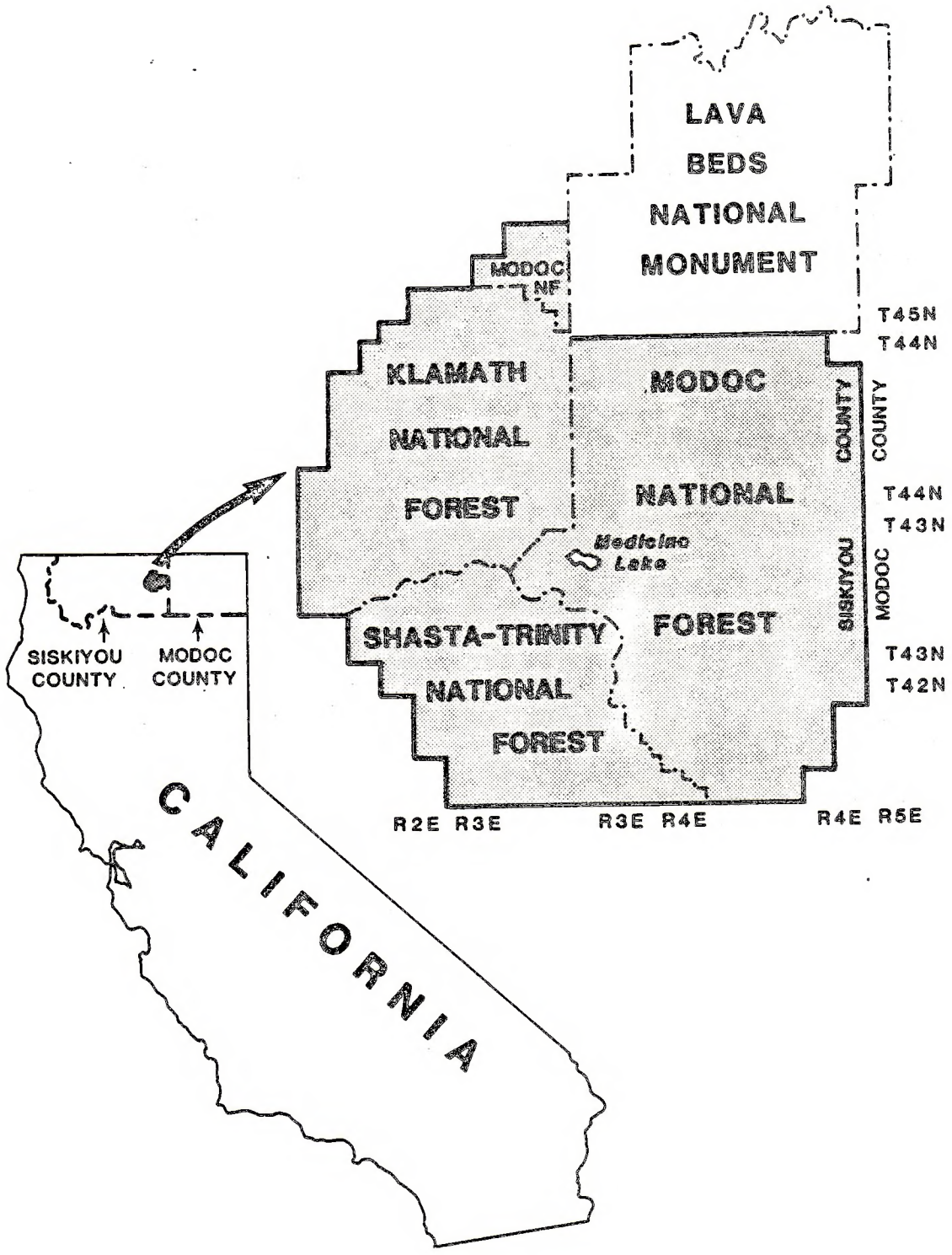
## LOCATION

The proposed lease area consists of 48,000 acres of unleased lands within a 161,000-acre study area in Siskiyou County, California. It borders Modoc County and includes portions of the Doublehead Ranger District, Modoc National Forest; the McCloud Ranger District, Shasta-Trinity National Forest; and the Goosenest Ranger District, Klamath National Forest (Map 1).

The lease area is within one hour travel time from the Klamath Basin, two to three hours from Redding, California, and two hours from Alturas, California.

Highway 139, approximately 10 miles east of the boundary of the study area, Modoc County, and Forest Service roads provide access to the area from the east. Visitor access from the north, west, and south is provided over Forest Service roads and through the Lava Beds National Monument.

# MAP 1 - LOCATION OF THE STUDY AREA



## ALTERNATIVES INCLUDING THE PROPOSED ACTION

### INFORMATION PERTAINING TO ALL ALTERNATIVES

#### Background

The Medicine Lake Planning Unit Land Management Plan (LMP) is the principal planning document applicable to the area being analyzed. The Environmental Statement (ES) on the planning unit, approved by the Regional Forester in September, 1978, stated that the following policy would apply to all management units within the planning unit:

> Provide for geothermal development where it is compatible with other uses; modify development in areas of high recreation or scenic values.

The LMP further stated that:

> An EA for geothermal leasing will be prepared that will identify specific concerns and management constraints for development.

#### Scenario

The electricity potential for the Glass Mountain area is estimated to be about 500 MW for a 30-year period. The method of estimation is presented in detail in Appendix A. Because power plants in developed fields are usually 55- or 110-MW units, this analysis will use 550 MW as the most likely development level.

Pilot power plants in unproven geothermal areas are generally between 10 and 25 MW. Industry will expand such units to about 55 MW if the pilot phase is successful. Development and utilization of this lease block might logically expand in 55-MW increments to 550 MW (ten power plant units) or 110-MW increments to 550 MW (five power plant units).

A geothermal operator may need approximately 2 to 5 years to discover and analyze the geothermal resource. One to two years is required to plan and permit proposed power projects, and construction will require 1 to 3 years depending on power plant size. A minimum of 5 to 10 years is usually needed from leasing to power on line at the first facility. Subsequent reservoir development to the 550-MW level may require another 20 to 25 years.

Developing a geothermal resource may be divided into three general phases: exploration, field development, and production. These phases, or activities, are described in detail in the following pages. A fourth and final phase is field abandonment.

Exploration

Preliminary exploration involves activities that are either casual use activities or exploration operations. Casual use activities include geologic mapping, spring-water or soil sampling, aerial surveys, etc. Exploration operations include surface geophysical surveys (electrical, magnetic, seismic, etc.) and shallow (less than 500 feet) to deep (500-4000 feet) temperature gradient hole drilling. Casual use and exploration operations involve:

(1) off-road foot traffic
(2) existing road or trail vehicle use
(3) off-road light vehicle use
(4) possible road/trail improvement for temperature gradient hole drilling.

These operations are considered non-surface-disturbing to minor surface disturbing activities. Temperature gradient holes are drilled by truck mounted rigs. Drill sites are usually located along existing trails or roads in level areas, a technique that causes minimal damage. Disturbed areas are about 40 x 60 ft for shallow holes and may reach 150 x 150 ft (about 1/2 acre) for the deepest temperature gradient holes. Some clearing and grading, including reserve pit construction may occur for the deep holes. Drilling time ranges from 2-3 days for shallow holes to 3-4 weeks for some deep holes.

The geothermal operator drills exploratory or wildcat wells to 4,000-10,000 foot depths to prove the geothermal resource's existence and extent, and to test the resource. These and further development operations are termed major surface disturbing operations. Operations during this stage include:

(1) road construction
(2) drill site construction
(3) truck and other vehicle travel
(4) production and injection well drilling
(5) well testing
(6) waste disposal
(7) well venting or bleeding (dry steam fields only)

Several deep production wells are needed to evaluate the extent and character of the reservoir. Drilling locations are selected by industry based on preliminary exploration results. Holes are drilled with large conventional oil field rigs and can be drilled vertically or at a slant. Ancillary facilities include a reserve pit, mud tanks, pipe racks, water tanks, generators, mud pumps, and air compressors if the well is drilled with air. Drill pads may range in size from 2 to 4 acres; some pads may eventually contain more than one well. Drilling times per well range from 2 to 6 months depending on difficulties encountered. The rig is then removed and the well is completed with a low well-head structure.

Immediately after drilling is completed, the operator usually determines the well's preliminary production capability by a short-term flow test. Short-term tests last only a few hours and effluent is directed into the reserve pit. Noise from an open air flow test can be considerable, but mufflers are used to reduce decibel levels. Long-term flow tests (30 days

or more) allow the operator to evaluate reservoir character and performance. Produced fluids are usually injected back into the reservoir via an injection well. The production well is connected to the injection well by a pipeline, and when flow tested, requires no muffling (Weres et al. 1977).

Table 1 shows the surface disturbance, by acres and percent, expected during the exploration stage for a 2560-acre lease. Actual acreage will vary depending on topography, existing road network, and other factors.

TABLE 1 - SURFACE DISTURBANCE - EXPLORATION DRILLING

Approximate surface disturbance expected to result from exploration drilling on one 2,560-acre lease.[1/]

| Unit | No. of Acres Disturbed per Unit | Units | No. of Acres Disturbed |
|---|---|---|---|
| Well Sites | 3.0 | 6 | 18 |
| Access Roads (25 ft wide; ½ mi length) | 1.5 | 5 | 8 |
| Total | | 11 | 26 or 1.0% of total lease area (2,560 acres) |

[1] Adapted from the "Final Environmental Analysis Record for Proposed Geothermal Leasing in the Randsburg - Spangler Hills - So. Searles Lake Areas, California." Prepared by Bureau of Land Management, Riverside District Office, July 1976.

Field Development

Favorable exploration, test drilling, and production testing programs will lead to additional well drilling and field development. Development of a large field can continue for more than 30 years. The development phase involves the same type of operations as are conducted in the exploration phase, but the amount and extent of activity is greater. The development phase also includes these additional operations:

(1) power plant construction
(2) pipeline construction
(3) electric transmission line construction
(4) upgrading access roads to permanent status

Data from The Geysers steam field is used to estimate the total surface disturbance that might result per power plant development at Glass Mountain. Table 2 shows the surface disturbance required for Pacific Gas and Electric Company's Unit 11 power plant at The Geysers.

TABLE 2 - SURFACE DISTURBANCE FOR 110-MW PG&E UNIT 11 LEASEHOLD[1/]

The Leasehold is 739.2 acres.

| Land Use | No./(miles) | Acres | % of Leasehold |
|---|---|---|---|
| Well Pads | 6 | 18.8 | 2.5 |
| Power Plant | 1 | 6.0 | 0.8 |
| Roads | (2) | 11.6 | 1.6 |
| Pipelines | (1.3) | 2.5 | 0.3 |
| Transmission Lines | (.65) | 3.9 | 0.5 |
| Replacement Well Pads | 3 | 7.9 | 1.1 |
| Total | | 50.7 | 6.8 |

[1/] The information on this table was supplied by Mr. W.C. Chouteau of Pacific Gas and Electric Co. The total percentage of surface disturbance will be approximately the same regardless of the total lease area. This information applies to a dry-steam resource only.

Wells at The Geysers produce superheated to saturated steam, whereas wells at Glass Mountain are expected to produce a steam/water mixture. The available work for a vapor-dominated system (i.e., at The Geysers) is greater than that for a liquid-dominated system (i.e., at Glass Mountain) (Kestin, 1980). The conversion efficiency to electricity is also greater for the vapor-dominated system, because in conventional geothermal power plants only the steam is used to produce electricity (DiPippo, 1980). Glass Mountain wells will likely produce fewer megawatts per well, therefore, more wells will be required to supply an equivalent power plant unit.

The number of wells at Glass Mountain that may be required per power plant unit can be determined by using the estimated mean reservoir temperature of 193°C (see Appendix A). The specific work output in electricity for a kilogram per second of flow at 193°C is estimated to be 62 kilowatts (kW) for a two-stage flash, resulting in approximately 20% steam flashed from hot water (Nathenson 1975). In hot water systems, most of the mass flow of wells is in the 500,000 lbs/hr (63 kg/sec) range. For a flow rate of 500,000 lbs/hr, a well will produce 4.0 MW. A 55-MW plant, therefore, would require approximately 14 wells that flow 500,000 lbs/hr. For comparison, about 16 wells are needed to produce 110 MW at The Geysers.

Five wells are estimated to be needed as makeup wells (SAI Engineers 1979) and an estimated 7 wells will be used for injection (two production wells per injection well)[1/]. A total of 26 wells, therefore, are believed necessary for a 30-year project life. To determine the reservoir area needed to support a 55-MW plant, both a 40-acre and a 20-acre spacing are used for production wells, and a 20-acre spacing is used for injection wells. When the production/injection well spacings are 40 acres/20 acres, the estimated reservoir area is 900 acres. When all wells are spaced at 20 acres, the reservoir area is 520 acres.

Table 2 shows that well pads average about 3.1 acres. About 3 wells are drilled per pad. Nine drill pads may be needed for the 26 wells, and these pads (including replacement well pads) will total 28 acres. The number of acres disturbed for roads, pipelines, and transmission lines will be considered proportional to the figures shown in Table 2, based on the respective reservoir area acreages. The reason is that the distances of these items should be proportionally shortened or lengthened. The power-plant pad size for the 55-MW plant is not expected to be much smaller than for the 110-MW plant shown in Table 2, because the required facilities are the same. The calculated acreages and percentages for the 520-acre and the 900-acre reservoir areas are shown in Table 3.

TABLE 3 - ESTIMATED SURFACE DISTURBANCE PER 55-MW POWER PLANT AT GLASS MOUNTAIN

| Land Use | Acres | |
|---|---|---|
| | 520-acre Area | 900-acre Area |
| Well pads (all production and injection wells) | 28.0 | 28.0 |
| Power Plant | 6.0 | 6.0 |
| Roads | 8.2 | 14.1 |
| Pipelines | 1.8 | 3.0 |
| Transmission Lines | 2.7 | 4.8 |
| Total | 46.7 | 55.9 |
| | (9.0% of reservoir area) | (6.22% of reservoir area) |

1/ Estimate is based on the discussions of various geothermal fields in DiPippo (1980).

Before constructing facilities for actual generation and transmission of power, a thorough evaluation is made of all available information related to the geothermal reservoir. The power plant location and gathering system configuration is limited by the distance the plant can be from the well sites (approximately 1 mile (5,280 ft.) maximum) and the minimum spacing of well producing zones (one well per 40 acres). Powerlines will be required to carry the electricity produced at the power plant sites to the transmission system now serving the area. Geothermal operators will have to establish powerline corridors within the lease block to make this connection. Corridors may be along existing roads or new corridors may be placed across previously undisturbed areas. A right-of-way granted for a 230-kilovolt transmission line at The Geysers to serve Occidental Geothermal's 80-MW power plant is 120 feet wide. The actual width of the surface disturbed along the corridor is expected to be about 60 feet.

After geothermal fluids are produced, usually they will be reinjected into the geothermal reservoir after useful heat has been extracted. The emplacement of geothermal fluids into the subsurface is usually well below the water table and beneath a confining stratum which serves to isolate the geothermal fluids from the shallower high quality water. Reinjection is necessary because it helps to maintain fluid pressure in a geothermal reservoir and thus to potentially extend the useful life of the system.

Reinjection also minimizes the amount of subsidence in softer, less competent rock which is generally subject to subsidence. Subsidence, however, is expected to be insignificant in the hard volcanic rocks of the Glass Mountain area. If there are objectionable chemicals in the geothermal fluids, they can also be returned to the same reservoir through reinjection.

### Production

Steam and electricity production involves full operation of all facilities. Activities during this phase will include routine monitoring and maintenance of the wells, pipelines, and power plants. Almost no construction should take place except for a few additional well pads for replacement production wells. Periodic replacement-well drilling will take place during this phase to maintain production levels. Most replacement wells, however, will likely be drilled from existing drill sites. The activities will be the same as those in the exploratory drilling stage of exploration. The work force requirements for this and other geothermal development phases are discussed under Environmental Consequences to Socioeconomic Conditions (page 45).

### Field Abandonment

Field abandonment will take place when geothermal resources can no longer be economically produced. Individual well and pad abandonment, however, will occur throughout the life of the field. Types of operations during abandonment include:

(1) well plugging and abandonment
(2) removing surface equipment and facilities
(3) restoring and reclaiming the surface
(4) relinquishing of leases and rights-of-way.

## Permitting Procedures

This section presents the Forest Service (FS) and Bureau of Land Management (BLM) pre- and post-lease permitting procedures, and environmental reviews, through full field development and abandonment.

A geothermal lease grants the lessee the nonexclusive right to explore for and the exclusive right to develop, produce, and utilize geothermal resources. Any operator (lessee) may, therefore, conduct casual use and exploration operations (including deep temperature gradient holes) either before or after a lease is issued. Only the lessee may perform test drilling, development, and production activities after a lease is issued.

Casual use operations require no authorizing permit. Before a lease is issued, the FS has authority to permit exploration operations by a Prospecting Permit. A lessee may conduct post-lease exploration operations under a Geothermal Exploration Permit which is issued by the BLM. Before the operator may begin operations, the surface manager must complete an

environmental analysis and identify mitigations for the proposed exploration sites. In cases where the operator proposes drilling or where surface geophysical surveys may disturb the surface, a field inspection is conducted before the analysis is completed and before issuing the permit.

The lessee must file a Plan of Operation (POO) and the appropriate permit application with BLM before conducting any major surface disturbing operations. The POO approval process is used to analyze effects and mitigate the surface disturbance that will result from the operation. Six plans of operation cover the various phases of geothermal development. These are:

1. Plan of Exploration
2. Plan of Baseline Data Collection
3. Plan of Development
4. Plan of Injection or Disposal
5. Plan of Utilization
6. Plan for Production

The operator submits a Plan of Exploration when proposing exploratory drilling. A Plan of Baseline Data Collection presents how the operator will collect environmental baseline data before production begins. This data must be collected for up to one year before production. The Plan of Development is the operator's proposal to develop the geothermal field after the resource is discovered. This plan covers additional wells and surface facilities (except the power plant) needed to fully develop the field. In the Plan of Injection or Disposal the operator must discuss the subsurface geologic and hydrologic environment and how fluid injection will be accomplished. A Plan of Utilization covers the utilization facility and electrical transmission lines, and the Plan for Production covers proposed production metering and royalty calculations.

In the POO the operator describes the proposed project, the equipment to be used, and how the operator will minimize hazards to personnel safety and to the environment. The BLM sends a notice to all interested parties inviting those parties to attend the field inspection that is required for each proposal. During the POO approval process the BLM and FS will conduct the site specific environmental analysis and determine the measures needed to mitigate environmental effects. The surface managers invite public comments, and will carefully consider all comments when preparing the environmental document. Environmental effects are mitigated, and the POO is approved with necessary special stipulations.

The operator may not begin operations under an approved POO alone. A permit application (Geothermal Drilling Permit, Geothermal Utilization Permit, or Geothermal Sundry Notice) approved by the BLM is also required. The permit application describes in detail the technical aspects of the proposed drilling and construction. When reviewing these applications, the BLM will consider such factors as drilling safety, blowout prevention, groundwater pollution, subsidence, and construction standards. The lessee must also provide an acceptable bond to cover any damages to the leased lands in case of operator default.

After a permit is issued, BLM personnel periodically inspect lessee operations to ensure that the operator complies with all lease, POO, and permit conditions. When operations cease, the lessee must remove all facilities, properly plug and abandon all wells, and reclaim and revegetate the disturbed surface according to BLM and FS instructions.

## Standard Operating Procedures and Applicable Laws and Regulations

Many environmental concerns regarding geothermal exploration, development, and production are addressed and resolved on the lease form (Appendix B). Of particular relevance are Sections 6-8, 13-15, 18, and 19.

Laws and regulations generally provide broad guidelines under which activities may be conducted. The provisions must be properly interpreted to consider the particular social, economic, land use, natural resource, cultural resource, environmental, or other significant factors. Some laws, especially those dealing with endangered species and cultural resources, are more explicit, and procedural actions are required in specified circumstances. Authority for enforcing the various laws and regulations that pertain to operations on a Federal geothermal lease has been delegated by Secretarial Order to the Bureau of Land Management. Although monitoring is done by several Federal, State, and local regulatory agencies, the BLM is the official contact with the lessee regarding leasehold operations. Discrepancies observed by other agencies are reported to the BLM, which takes the necessary administrative or corrective action.

Table 4 lists some of the laws, regulations, and guidelines that affect geothermal development of public lands. This list is not intended to be a complete list of all laws and regulations, but rather a compilation of the more important statutes.

The Federal air and water pollution control acts delegate responsibilities to maintain air and water quality standards to state and local authorities. Geothermal operators must obtain required air and water permits from these agencies before the operators begin major surface disturbing work.

The BLM provides a copy of all POO's to the State Historic Preservation Officer (SHPO). The SHPO is asked to provide comments on each proposal. Before operations begin, the lessee is required by Section 18 of the Geothermal Lease to provide the BLM with a certified statement that no archeological or historical values exist where the operation is planned.

The Geothermal Steam Act, leasing and operating regulations, and GRO Orders provide the general and specific guidelines for developing geothermal resources. These provisions require pre- and post-lease environmental analyses under the guidelines of the National Environmental Policy Act of 1969. The GRO Orders are specific requirements written to supplement the Geothermal Steam Act and regulations. The orders detail the technical and environmental requirements necessary to ensure safe operations and to ensure mitigation of short- and long-term environmental hazards. All Federal geothermal operators must use these requirements to submit POO's and permit applications, and to conduct exploration and development activities.

TABLE 4 - APPLICABLE STATUTES, REGULATIONS, AND POLICY DOCUMENTS

Geothermal Steam Act of 1970 (Public Law 91-581, 84 Stat. 1566)

Code of Federal Regulations, Title 43, Part 3200 (Geothermal Leasing and Operating Regulations)

Geothermal Resources Operational (GRO) Orders

1. Exploratory Operations
2. Drilling, Completion, and Spacing of Geothermal Wells
3. Plugging and Abandonment of Wells
4. General Environmental Protection Requirements
5. Plans of Operation, Permits, Reports, Records, and Forms (Draft)
6. Pipelines and Surface Production Facilities
7. Production and Royalty Measurement, Equipment, and Testing Procedures

Secretarial Order 3087 - Organizational Restructuring of the Department of the Interior Minerals Management Functions (December 3, 1982)

Geothermal Resources Lease, Form 3200-21

U.S. Department of the Interior, Geothermal Environmental Advisory Panel - Guidelines for Acquiring Environmental Baseline Data on Federal Geothermal Leases (1977) (Part of GRO Order No. 5)

Memorandum of Understanding for the Geothermal Program in California - Bureau of Land Management and Forest Service, May, 1984

National Environmental Policy Act of 1969 (Public Law 91-190, 83 Stat 852)

Code of Federal Regulations, Title 40, Part 1500-1508 (Council on Environmental Quality Regulations)

Federal Land Policy and Management Act of 1976 (Public Law 94-579, 90 Stat. 2743)

National Historic Preservation Act of 1966 (Public Law 89-665, 80 Stat. 915) Code of Federal Regulations, Title 36, part 800 (Procedure of the Advisory Council on Historic Preservation)

Endangered Species Act of 1973 (Public Law 93-205, 87 Stat. 884)

Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500, 86 Stat. 816)

Clean Water Act of 1977 (Public Law 95-217, 91 Stat. 1566)

Clean Air Act Amendments of 1977 (Public Law 95-95, 91 Stat 685)

Antiquities Act of 1906 (Public Law 59-209, 34 Stat. 225)

Archaeological Resources Protection Act of 1979 (Public Law 95-96)

ALTERNATIVES CONSIDERED

Alternative A - No Leasing (No Action)

Lease applications will be returned without action, and no geothermal exploration, development, or utilization will be permitted.

Alternative B - Lease With Stipulations (Proposed Action)

The proposed action is to lease 48,000 acres of National Forest land for the development of geothermal resources in the Glass Mountain study area with the standard lease stipulations[1/] plus the special stipulations listed below. The location of the parcels proposed for leasing is shown on the resource and mitigation maps in the Map Packet.

Special Stipulation No. 1 - Protection of Surface Resources:

The lessee shall not occupy or use the surface of the following described lands with the following exception: surface-disturbing activities will be permitted by the BLM in consultation with the Forest Supervisor if the lessee can demonstrate that multiple-use management objectives for the critical resource of the area will be met.

This stipulation applies to the recreation management area surrounding Medicine Lake, the area under consideration for expansion of the Lava Beds National Monument, 12 geological features, and additional areas identified in the Mitigation section. These areas are delineated on Maps 3 and 5.

This stipulation may allow activities in the Geological Areas, Recreation Management Area, and the Boundary Adjustment Area. The stipulation, however, permits surface occupancy only where the lessee can demonstrate that land management objectives for the critical resources involved can be met. The stipulation is intended to allow as much exploration and development as possible without risking the critical values of the area.

Special Stipulation No. 2 - Protection of Wildlife

In order to protect critical seasonal and year-round wildlife habitat for deer, bald eagles, goshawks, and marten, no activities will be allowed in the following areas during the times specified. For location of the areas, see Maps 2 and 5 (in Map Packet).

---

[1/] See Appendix B - Geothermal Lease Form and refer to GRO Orders, U.S.G.S., U.S.D.I., October 1979.

-- Winter deer range: November 1 to May 1
-- Bald eagle winter roost core areas and nesting habitat: year-round
-- Remainder of bald eagle winter roost habitat: November 1 to April 15
-- Goshawk nesting territories: April 1 to August 30
-- Old growth forest (marten habitat): year-round .
-- Meadows: year-round

Exceptions will be made if the lessee can demonstrate to the BLM, in consultation with the Forest Supervisor, that the proposed activity will not have an adverse impact on the wildlife habitat involved. During the periods when entry is allowed, limited surface disturbance including placement of some pipelines will generally be permissible. However, extensive development such as power plants are unlikely to be permitted.

This stipulation is intended to allow as much geothermal activity as possible while assuring that wildlife management objectives are met. It is not intended to restrict normal maintenance of existing or authorized facilities.

Special Stipulation No. 3 - Protection of Surface Waters

Existing water in stock tanks, ponds, lakes, reservoirs, springs, creeks or streams is not available for use in any activity under this lease unless specifically permitted by the Forest Supervisor, except where the lessee has water rights or the authorized use of such water rights. Access for wildlife watering at all natural water sources appropriated for operational uses will be provided. No surface disturbance is allowed within 700 feet of streams, lakes, ponds, springs, wet meadows or other water sources unless specifically permitted by the Forest Supervisor.

Areas affected by this stipulation are not shown on Map 5. However, all known water sources (see pages 24 and 25) are within the areas covered by Special Stipulations 1 and 2. Stipulations for the protection of specific water sources will be developed and imposed at the permit stage.

Alternative C - Lease with the Exception of Sensitive Areas

This alternative provides for leasing approximately 32,000 acres of National Forest land for the development of geothermal resources. Critical Wildlife Areas, Recreation Management Areas, Geological Areas, and the Boundary Adjustment Area would not be available for leasing. It is similar to Alternative B except that the areas covered by Special Stipulations 1 and 2 in Alternative B would not be available for leasing under any circumstances.

Special Stipulation No. 3 would apply to surface water in the area leased. No other special stipulations would be required.

## AFFECTED ENVIRONMENT

### KEY ISSUE-RELATED RESOURCES

#### Wildlife

The study area contains three broad vegetation types. These types (coniferous trees, high elevation shrubs and low elevation shrubs) include a number of wildlife habitat types (Laudenslayer, 1982). In addition, the study area includes several thousands of acres of barren lava flows. The basic eight wildlife habitat types include: eastside pine, mixed conifer, red fir, lodgepole pine, subalpine forest, montane shrub, alpine shrub and big sagebrush.

The habitat types or combination of types are used by specific kinds of animal life. The range and tolerance of a number of vertebrate species common to these habitats, has been documented for a selected group of animals. These selected animals are labeled as Management Indicator Species (MIS). The MIS were chosen as they are predicted to be responsive to changes in their habitats. For each MIS, a Habitat Capability Model (HCM) has been developed. These models can be used to predict the occupancy and use of various habitat types by the MIS, and the potential impacts of vegetation changes and human influences on the species.

Nearly 400 wildlife species are found within the study area. Many species are permanent residents while others are migrants from other areas. Because there are a large number of wildlife species in the study area, only the MIS will be used for the analysis. Habitat information is provided for the key use areas for each MIS. The key habitat areas are identified from the California Department of Fish and Game's 1976 report on the Medicine Lake Planning Unit, and Forest Service Land and Resource Management Planning data collected on the Modoc, Klamath and Shasta-Trinity National Forests.

In addition to the MIS, several special habitats have been identified in the study area. These special habitats include: old-growth forests, snags, meadows, water resources and fisheries. Management emphasis has been placed on these habitats by the Forest Service.

#### Mule Deer

The study area is within the various seasonal ranges of the McCloud Flat deer herd (Map 2 in Map Packet). This deer herd is a complex of smaller herd units with a common summer range centered in the Medicine Lake Highlands. The California Department of Fish and Game is currently preparing a management plan for the McCloud Flat deer herd.

Most of the study area is summer range for mule deer. Preferred summer deer habitat is discussed in the HCM (Ross et al., 1982) and by Thomas et al., Wildlife Habitats in Managed Forests 1979. Simplified, a suitable habitat condition for deer is a mosaic of approximately 50 percent cover area and 50 percent forage area. A highly suitable habitat condition would result when these percentages of cover and forage areas are spatially arranged so that maximum utilization of habitat occurs. The proportion of

forage area/cover area can vary from 30/70 to 70/30, and remain suitable for deer habitat. Mule deer also require high quality forages, cover for protection from predators and weather, and freely available water.

The study area also contains fall/spring transitory and winter ranges for the deer herd. Cover and forage ratio requirements are similar to the summer range, however, deer diets are markedly different during the various seasons. Salwasser (1979) discusses seasonal deer forage preferences.

The study area is transversed by a number of deer migration corridors. These corridors are used by the herd in their annual movements to and from the summer range. Deer summering in the study area may winter on as many as four separate winter ranges.

The deer in the study area are vulnerable to harassment by people. This is largely due to the high density of roads created by timber management activities. As a result, the Shasta-Trinity National Forest has implemented a seasonal limited access area south of Medicine Lake. This closure is during deer hunting season only. The Klamath National Forest is proposing a seasonal closure area north of Medicine Lake. The Klamath's proposed closure extends from the beginning of deer hunting season through the end of March. These limited access areas constitute a large portion of the study area.

Water is a known limiting habitat variable for deer. Natural water sources, available through the end of summer, are limited to a few lakes near Medicine Lake, and Paynes Spring.

Bald Eagle

Bald eagles (a federally listed endangered species) can occur throughout the study area. The Klamath Basin, which is adjacent to the study area, has one of the largest wintering concentration of bald eagles in the United States, outside of Alaska. The area has one known nesting territory and portions of two major Klamath Basin winter roosts (Map 2). Shimamoto and Newman (1982) discuss the bald eagle's habitat requirements and nesting territories.

The nesting territory is approximately one-half mile south of Medicine Lake. The territory is known to have been active and fledged young in 1977-79. The nest was not monitored between 1979 and 1983. Since resuming monitoring in 1983, the nest has not been used.

Bald eagles are commonly seen in the Medicine Lake Caldera throughout the summer. Sightings have also been recorded at other nearby, smaller lakes.

The Three Sisters winter roost is located on the Klamath National Forest on the northwest boundary of the study area. During the wintering period (November 1 to April 15), approximately 100 eagles frequent this roost on a nightly basis. Eagle numbers may swell to nearly 200 per night, depending upon foraging conditions at the nearby Tulelake and Lower Klamath National Wildlife Refuges.

The Klamath National Forest has implemented a management plan for the roost area. The plan provides management and protection options in the core roost area, which is one mile north of the study area. The Forest has also developed and implemented timber sale contract clauses imposing speed limits on log truck traffic through the roost area in the winter months. This is done to prevent eagle-vehicle collisions, while the eagles are feeding on road-kill deer and rabbits.

The Caldwell-Cougar winter roost occurs on the Modoc National Forest. This roost is entirely in the northeast corner of the study area, except that portion which lies within the Lava Beds National Monument.

A variable number of eagles use the Caldwell-Cougar roost. Quite often only 7 to 15 eagles use the roost. However, over 300 eagles have been counted as they fly off the roost. Again, the nightly population varies due to local foraging conditions. This roost area has no formal management plan, but there is an interim management plan. The Forest Service has modified a timber sale to exclude those cut units inside the roost area.

Two other major winter roosts, located nearby, contribute to the overall significance of the Klamath Basin as a wintering area. Kiester (1981) discusses the characteristics of the Three Sisters, Caldwell-Cougar, and other winter roosts of the Klamath Basin.

Goshawk

Much of the study area contains suitable habitat for nesting goshawks. The goshawk has been declared a sensitive species by the Regional Forester and receives management emphasis similar to Federally listed threatened and endangered species. The Forest Service has identified a number of goshawk nesting territories (Map 2). Most of these territories are presently protected from management activities. Disturbance near the nest sites is usually prohibited from April 1 to August 30. Camilleri (1982) discusses goshawk habitat requirements.

Marten

The marten is a special interest species and occurs throughout much of the higher elevation forests of the study area. The animal prefers red fir and other true fir forests. It is an indicator of old-growth forests, and depends upon logs, snags and meadow areas. Spencer (1984) has shown that the marten inhabits most old-growth red fir and higher elevation white fir forests. Airola (1982) discusses habitat requirements for the marten.

Old-Growth Forests

The study area contains several thousand acres of old-growth forest areas (Map 2). These old-growth areas consist of mixed conifer, red fir, white fir and subalpine forest in which the average stem diameter (dbh) is greater than 24 inches and the percent crown canopy closure is greater than 40 percent. These stands are recorded in stand sizes greater than 20 acres and the age of the stands should be greater than 180 years.

Forest Service management policy is to retain five percent of the commercial forest land base in old-growth forest. This policy is designed to meet the legal requirements of maintaining viable wildlife species populations, in this case, those that are dependent upon old-growth forests (National Forest Management Act 1976).

The forests have identified old-growth stands during the timber sale planning process and designated those stands for old-growth management.

### Snags

Snags provide habitat for many wildlife species in the study area, including the marten. A number of bird and mammal species are directly dependent upon snags for all or part of their life cycle. The Forest Service snag management policy has directed the Forests to retain a minimum number of snags per acre on commercial forest lands. The number of snags per acre required varies from 1.4 to 3.0 per acre. Airola et al. (1982) discuss this special habitat in his HCM.

### Water Resources

The study area has limited water resources. Natural water is limited to several lakes near Medicine Lake and Paynes Spring, all on the Modoc National Forest. The Forests have developed several wells and guzzlers and numerous small ponds and catch basins that provide season-long water for range and wildlife. The Forests have also planned development of more range and wildlife water sources. Water is a limiting factor in range and wildlife use of habitats in the study area. Most natural water sources are also within foreground view zones of recreation areas.

### Meadows

The Shasta-Trinity National Forest has identified several dry meadows as favorable habitat for deer and other wildlife (Map 2). These meadows have been given special management consideration in timber sales and reforestation.

### Fisheries

Medicine Lake, Little Medicine Lake, Bullseye Lake, and Paynes Creek are the only areas within the study area with habitat conditions capable of supporting a fisheries resource. These areas provide suitable habitat for arctic greyling, and brook and rainbow trout.

The fisheries resource in Medicine Lake, Little Medicine Lake, and Bullseye Lake is maintained on a put-and-take basis through a stocking program by the California Department of Fish and Game.

## Recreation

The Glass Mountain geothermal study area offers a variety of year-round recreation opportunities.

Because of the low population densities in this portion of California and the distance from major metropolitan areas, the area receives considerably less recreation use than other public lands in the State.

Map 3 (in Map Packet) identifies the designated recreation management area around Medicine Lake. This area contains developed recreation facilities as well as areas of concentrated dispersed recreation use.

Developed facilities within the recreation management area are as follows.

1. Medicine Campground

   An existing developed recreation site consisting of 44 camping units on the north shore of Medicine Lake.

2. Hemlock Campground

   An existing developed recreation site consisting of 19 camping units on the north shore of Medicine Lake.

3. Headquarters Campground

   An existing developed recreation site consisting of 9 camping units on the west end of Medicine Lake.

4. Medicine Lake Swimming Beach

   An existing developed day use area with picnic facilities and beach.

5. Medicine Lake Boat Ramp

   An existing developed boat launch facility operated in cooperation with Siskiyou County.

Uses within the developed areas include overnight camping, and day use activities such as swimming, boating, waterskiing, and fishing.

Currently the demand for facilities seldom reaches the capacity. In 1983 there were approximately 12,600 reported visitor days of use related to the developed facilities at Medicine Lake (Table 5).

The operating season for the developed sites is June 15 through October 15 or about 123 days per year.

In addition to the Forest Service maintained developments, there are three recreation residences under special use permit which are located in the vicinity of Medicine Lake. An additional 300 visitor use days annually are attributed to these residences. A development of recreation residences is also located on private lands adjacent to Medicine Lake.

There is one developed campground located in the Lava Beds National Monument. This campground contains 45 sites and has a capacity of 225 PAOT. This facility is provided for visitors to the Monument and present use is close to the developed capacity during much of the summer season.

TABLE 5. RECREATIONAL USE AND CAPACITY

| Facility | (PAOT) 1/ | Practical Capacity 2/ Visitor Days | Visitor Days |
|---|---|---|---|
| Medicine Lake Boat Ramp | 80 | 3,936 | 200 |
| Medicine Lake Swimming Area | 155 | 7,626 | 300 |
| Medicine Campground | 220 | 21,648 | 8,800 |
| Hemlock Campground | 95 | 9,348 | 2,700 |
| Headquarters Campground | 45 | 4,428 | 600 |

1/ Persons at one time.

2/ Practical Capacity = 40% of theoretical maximum capacity.

The Lava Beds National Monument furnishes interpretive opportunities for recreationists viewing the unique volcanic formations of the area and the battlefield of the Modoc Indian War. Wilderness areas are also maintained within the Lava Beds National Monument. Lands within the Lava Beds National Monument are not available for geothermal leasing; nor is directional drilling allowed from outside the Monument.

Recreational use of lands within the study area but outside of developed areas accounts for approximately 80 percent of the total recreation use. This use occurs both within and outside of the recreation management area.

Dispersed use includes such activities as camping, hunting, fishing, snowmobiling, cross-country skiing, off-road vehicle use, nature study, driving for pleasure, hiking, wood gathering, and other similar activities. Heavy dispersed use occurs near Blanche and Bullseye Lakes, Paynes Spring, and Schonchin Spring.

Big game hunting with associated camping, and driving for pleasure are the major dispersed recreation activities. The public lands within the KGRA receive some of the State's heaviest big game hunting pressure. This use accounts for over half of the total dispersed use of the area. Mule deer hunting is the most popular activity.

The dispersed recreation season is usually limited to June through early October due to the long winters when much of the area is inaccessible. Over the snow use accounts for the majority of the winter use of the area. Existing roads are used as snowmobile trails. Some off-road use also occurs.

A major snowmobile trailhead and trail system is proposed for the northwest corner of the study area. The trailhead will be located at Four Corners along the Davis Road with designated trails reaching out to the east, west and north.

Off-road vehicle use is generally associated with wood gathering and big game hunting and is found throughout the area. Off-road vehicle use is prohibited in the Burnt Lava Flow and is limited to existing roads and trails, except for over the snow use, in the area roughly corresponding to the recreation management area.

Additionally a road closure is enforced during the general State hunting seasons in the area southwest of Medicine Lake. The purpose of this closure is to enhance the quality of the hunting experience and to reduce deer harassment. Additional road closures are proposed northwest of Medicine Lake for a variety of resource management reasons.

## Visual Resources

The Glass Mountain KGRA is characterized by a diversity of distinct land forms and vegetation. The volcanic history of this area has resulted in geologic features such as volcanic rims, cinder cones, collapsed lava tubes, lava flows and craters. The geologic features combined with the mixture of timber vegetation, including lodgepole pine, sugar pine, red fir, incense cedar and ponderosa pine, provide the unique scenic qualities of this area.

### Variety Class

The scenic quality of the landscape has been classified according to the variety and character of the natural elements that are present. There are three variety classes which identify levels of scenic quality:

> Variety Class A (Distinctive) - Forms, lines, colors and textures found in the landscape features such as terrain, vegetation, water and geology, combine into rich variety and unusual or outstanding quality compared to the overall landscape character type of the region.
>
> Variety Class B (Common) - Landscapes which contain enough variety in forms, lines, colors and textures of the landscape features to be pleasing but which tend to be common throughout the regionwide landscape character type and are not outstanding in visual quality.
>
> Variety Class C (Mineral) - Landscapes which have little change in line, form, color or texture resulting in a monotonous landscape lacking in scenic variety.

### Visual Concern

The visual concern levels within the area are a function of two factors, the amount of use an area receives and the level of concern of the users for scenery. First, the major use of this area has been recreation associated with the developed sites at Medicine Lake and dispersed recreation associated with deer hunting in the fall. The short summer recreation season, limited by snowfall and restricted winter access, and the remoteness of the area relative to major metropolitan areas have kept recreation use at low levels on an annual basis. On a seasonal basis, however, recreation use is substantial. The potential for attracting increased

recreation use is good based on several factors including the quality of the area, the improving economy and the rapidly increasing population of northern California.

The second factor affecting visual concern is the level of concern for scenery. The level of concern is assumed to be high among recreationists visiting the area based on the distances the recreationists travel, public input into resource projects and informal surveys.

Visual Sensitivity

Sensitivity levels are assigned to travel routes or use areas based on the amount of use they receive and the level of concern of the viewers for scenic landscapes. Sensitivity levels include levels one, two and three with level one being the most sensitive and level three being the least sensitive travel routes or use areas.

Distance Zones

The viewer's proximity to the seen area is classified into three distance zones: foreground (0-3/8 miles), middleground (3/8-4 miles) and background (4 miles +). Areas that are not viewed from a sensitivity level one or two travel routes or use areas are classified as unseen.

Visual Quality Objectives

Visual quality objectives (VQO) have been assigned to all areas based on the combination of variety class, sensitivity level and distance zone. Five VQOs describe the degree of acceptable alteration of the natural landscape based upon the relative aesthetic importance. The degree of alteration is measured in terms of the visual contrast created by the surrounding natural landscape. Visual quality objectives are defined in the National Forest Landscape Management Handbook (USDA Forest Service 1981).

The type of use that will meet a particular visual quality objective will depend upon: 1) the nature of the proposed use; 2) the physical capability of the landscape to absorb modification; and 3) visual sensitivity.

The primary areas of visual resource concerns are those areas with a preservation or retention VQO (see Map 4). Specifically those areas viewed from the Medicine Lake Road, Monument Headquarters Road, Fourmile Hill Road, Monument Road, Powder Hill Road, Davis Road or the Medicine Lake recreation areas are critical visual zones with retention or partial retention visual quality objectives. The Medicine Lake Unit Plan further identified those areas viewed in the foreground of the Black Mountain-Tionesta Road as critical visual zones with a retention visual quality objective.

## Climate and Air Quality

The temperate semiarid climate of the region is characterized by relatively hot, dry summers and cool, moist winters and springs. Isotherms usually follow slope and elevation contours. Weather records gathered over the

past 20 years at Indian Well Headquarters (4,770 feet above sea level) show a mean summer maximum temperature of 77°F and a mean winter minimum of 24°F. Temperatures as high as 80°F have been recorded in January. Yearly extremes range from -8 to 101°F. Average annual snowfall is 41.0 inches. Dry southwesterly winds prevail in the Lava Beds National Monument. Winter snowstorms generally arrive from southwest or northwest directions. Gusty winds of high velocity are not uncommon with storm gusts exceeding 60 mph. The study area is subject to severe thunderstorms during the late spring and summer months with thunderheads building up over the cooler Medicine Lake Highlands. Mt. Shasta, forty miles to the southwest, influences weather patterns over the area. Climatic conditions vary considerably between 4,000 and 5,700 feet elevations.

The air resource is of high quality. Few pollutant sources exist in the Klamath Basin which affect the quality of the air resource. Those which do exist affect the air quality indirectly. Since the Basin is primarily an agricultural area, airborne fugitive dust is one of the major contributors to particulate matter in the air, while agricultural burning and wildfires also occasionally contribute significant amounts of particulates. These sources occur primarily in the summer season. In the winter, scenic vistas are diminished only by fog or local storms. There is no major permanent pollutant source within the Basin area which would affect air quality or scenic vistas. Currently, the only known pollution is airborne dust.

Two wilderness areas, totaling 28,460 acres, were designated as mandatory Class I air quality areas in the Clean Air Act Amendments of 1977. These wilderness areas are in the Lava Beds National Monument. The remainder of the region was established as Class II. Class I is the most stringent air quality category and was assigned by Congress to prevent further deterioration of air quality in these areas. The Federal land manager was given an affirmative responsibility in the Act to identify and protect the air quality related values (AQRVs) of these Class I areas. Efforts to include the remaining portion of the Monument and the detached Petroglyphs Section to Class I are currently in suspense.

Geothermal development in the Highlands will have to take into account the Class I air quality values of the monument's wilderness areas and not exceed Class I requirements.

Class I and II air quality standards are shown below.

| | Maximum Allowable Increase (micrograms per cubic meter) | |
|---|---|---|
| | Class I | Class II |
| Particulate Matter: | | |
| Annual geometric mean | 5 | 19 |
| Twenty-four hour maximum | 10 | 37 |
| Sulfur Dioxide: | | |
| Annual arithmetic mean | 2 | |
| Twenty-four hour maximum | 5 | 91 |
| Three hour maximum | 25 | 512 |

## Water

### Ground Water

In the caldera area of the Medicine Lake Highlands, the depth to the first major aquifer is generally 200 feet. On the flanks of the shield volcano, the depth is very erratic and varies from 300 feet to an excess of 1,000 feet. At the base of the shield volcano, the depth of the water table is approximately 500 feet.

The Forest Service uses two locations for withdrawing water. One site is at Medicine Lake and the other site is at the Tionesta well. At the Medicine Lake site, the water is pumped from the lake. The Tionesta well is located at the base of shield volcano. The water at the lake is used for domestic consumption, recreation, road construction and fire suppression. The water at the Tionesta well is used for road construction, livestock and fire suppression.

### Surface Water

Paynes Creek, Crystal Springs Creek, Medicine Lake, Bullseye Lake, Blanche Lake and Little Medicine Lake are the only major surface waters in the Medicine Lake Highlands. Beneficial water use includes domestic consumption, fish habitat and recreation (Table 6).

Water quality monitoring has only been done at Medicine Lake, but all other sources are believed to be excellent. Medicine Lake water has been found to be naturally low in nutrients and buffering capacity, has very good clarity, and is therefore of good quality (Jones 1983).

TABLE 6 - BENEFICIAL USE OF WATER IN THE MEDICINE LAKE HIGHLANDS

| | Domestic Use | Fish Habitat | Recreation |
|---|---|---|---|
| Paynes Creek | | X | X |
| Crystal Springs Creek | X | X | X |
| Medicine Lake | X | X | X |
| Bullseye Lake | | X | X |
| Blanche Lake | | | X |
| Little Medicine Lake | | X | X |

## Geological Features

The Medicine Lake Highlands is a large shield volcano which was formed from eruptions of olivine bearing andesite. The apex of this shield volcano was located at what now is known as Medicine Lake. An elliptical

caldera approximately six by four miles was formed when the center of this shield volcano collapsed. After collapse, molten rock was forced up through the resulting ring fractures, erupted from "rim volcanoes," and eventually completely covered the escarpment created by the collapse (see Anderson 1941).

It is also theorized that the summit may not have collapsed, but that eruptions built new volcanoes on the rim. Under either theory, these rim volcanoes are Mount Hoffman, Badger Peak, Red Shale Butte, and Lyons Peak. Many other lava flows, cinder cones, and glass flows erupted on the flanks of this shield volcano. Some of these flank volcanoes are Big Glass Mountain, Little Mount Hoffman, Little Glass Mountain, Pumice Stone Mountain, Burnt Lava Flow, Callahan Flow, and Stud Hill.

The entire area has undergone very recent volcanic activity, including the eruption of basalt flows, obsidian flows and domes, and pyroclastic pumice. The more recent basalts are thought to be as young as 500 years.

Erupted materials include andesite, dacite, rhyolite, basalt, cinders, pumice, obsidian and ash. Landforms within the Highlands are cinder cones, caldera lands, craters, irregular lava flows, steep volcanic side slopes, recent lava flows, and basalt capped plateau. Much of the caldera rim and floor has been influenced by glaciations.

This relatively recent volcanic activity has produced numerous geologic features of particular interest.

Geologists have recognized several unique geological features in the area. The Land Management Plan calls for protection of these areas. More than minor surface disturbance in these geological areas would seriously impair or destroy their scenic and scientific values. The Burnt Lava Flow, the Medicine Lake Glass Flow, and the Glass Mountain Glass Flow have been classified as Geological Special Interest Areas. These, and other geologic features that have been identified for protection as Geological Areas in the Land Management Plan for the Medicine Lake Planning Unit (U.S. Forest Service 1978), are listed on Table 7 and shown on Map 3.

TABLE 7 - UNIQUE GEOLOGIC FEATURES IDENTIFIED FOR PROTECTION

| |
|---|
| Burnt Lava Flow |
| Little Glass Mountain |
| Pumice Stone Mountain |
| Paint Pot Crater |
| Callahan Lava Flow |
| Glass Mountain Glass Flow |
| Medicine Lake Glass Flow |
| Giant Crater Lava Tube System |
| Deep Crater |
| Astronaut Crater |
| Shastine, Chimney, and Giant Craters |

## Lava Beds National Monument

The purpose of Lava Beds National Monument is to provide for the use and enjoyment of the natural, historic, and scientific objects and resources therein by the public without diminishment so that they may be similarly used and enjoyed by future generations.

Lava Beds National Monument was established by Presidential Proclamation on November 21, 1925 which states:

> Whereas, lands of the United States within the area herein described . . . contain objects of such historic and scientific interest as to justify their reservation and protection as a National Monument; . . . .

Initially, the Monument was placed under the administration of the U.S. Forest Service. In 1933, administration was transferred to the National Park Service by Executive Order No. 6166. On April 27, 1951, two additions were added to the Monument by Presidential Proclamation No. 2925, Mammoth Crater and the portions of Petroglyphs Section. Public Law 92-493, enacted on October 13, 1972, established 28,460 acres of Lava Beds as wilderness. Slight adjustments, adding 321.58 acres and deleting 60.12 acres along the northern boundary separating the Monument from the Tule Lake National Wildlife Refuge, were made on October 26, 1974, and are contained in Public Law 93-477.

The geologic significance of Lava Beds National Monument is evidenced by superb examples of central and fissure type eruptions and block faulting. Examples of central eruptions are the numerous cinder cones lying along the flank of the shield volcano known as the Medicine Lake Highlands, which was also created by a central eruption. Additional geologic features of significance are the many volcanoes in the Peninsula and Petroglyph area, which were created while under water; and the distant view of Mount Shasta, outside the boundary, but visible evidence of the Cascade Mountain range and the Columbian Plateau, of which Lava Beds is a part. Numerous spatter cones, lava tubes and recent surface flows are also visible evidence of recent fissure flow activity. Lava Beds has approximately 300 known lava tubes which were created by this recent activity. Nowhere else in the National Park System are all of these features so easily visible and accessible for public appreciation.

The geologic formations and other natural resources of the area contributed to the setting for historic events in the Lava Beds and its significance in U.S. history. During the Modoc Indian War of 1872-1873, a small band of Modoc Indians successfully held off overwhelming forces of the U.S. Army cavalry, infantry and artillery because of their detailed knowledge and use of incredible natural fortifications formed by the lava flows just south of Tule Lake. These flows provided rifle pits, connecting trenches, shelters from mortar fire, and finally, a natural escape from encirclement. Occurring only seven years after the end of the Civil War, it was the only Indian war on record in which the Army used mortars to assault an Indian stronghold. The war was characterized by embarrassing reversals for the military and it posed significant costs. It was rife with treachery on both sides, culminating with the only death of a General Officer of the Regular Army at the hands of Indian warriors. Because the Modocs were

sufficiently knowledgeable of Anglo-American society, the death was considered murder since it occurred during a truce conference under a white flag.

Particular sites associated with the Modoc War which have been identified include Captain Jack's Stronghold, Gillem's Camp, Canby's Cross (the Canby murder site), the Thomas/Wright Battlefield, and Hospital Rock. Several of these sites include stone structures built either by the Modocs or the Army during the campaign. Some of the best of the stone fortifications, however, are southeast of the Monument and outside its boundaries.

Other historic sites within the Monument, but not associated with the Modoc War and thus considered of local or regional significance, include a pioneer wagon road which crossed the Monument east to west in the vicinity of Caldwell Butte, a section of logging railroad grade near the southwest corner of the Monument, and a number of "rustic" architectural style structures built by the Civilian Conservation Corps prior to World War II.

Plant and animal life within the Monument are characteristic of the sagebrush-bunchgrass and mahogany-juniper woodlands, and to a minor degree, ponderosa pine ecosystems. To date there is little representation of these typical Great Basin communities in the National Park System. Approximately 1,500 to 2,000 mule deer winter in the Monument, while a small population of pronghorn antelope utilize summer range here. Coyotes abound in the Monument along with many species of raptors, both seeking the abundant rodent populations. A wintering population of bald eagles (an endangered species) utilizes an evening roost site in the Monument from November through March, flying directly over the Visitor Center area to their daily feeding sites on the Tule Lake National Wildlife Refuge.

Many archaeological sites have been recorded in the Monument, and are concentrated mostly along the north boundary, which approximates the old shoreline of Tule Lake. Remains of both prehistoric Indians and of the Klamath-Modoc Indians are present. The lifestyle of these aboriginal people was closely attuned to the whole range of ecosystems represented in the Monument and tells a fascinating story of man in a seemingly harsh environment.

The area to the southwest of the Lava Beds National Monument (Map 5) which includes Cinder Butte and Black Lava Flow has long been recognized as an area of important resource values worthy of preservation. An interagency study of this approximately 5,100-acre area has been under way for a number of years to determine the best method and jurisdiction for preserving and interpreting these values. The area is known as the Boundary Adjustment Area.

## OTHER RESOURCES

### Timber and Other Vegetation

The Glass Mountain Study Area encompasses approximately 161,000 acres. There are 4,000 acres of private ownership within the boundary, leaving 157,000 acres administered by the Department of Agriculture. Approximately 16,000 acres, or 10 percent of the Federal ownership, is occupied by large

volcanic deposits. Of the remaining 141,000 acres, it is estimated that 110,000 to 120,000 acres are capable, available and suitable for growing trees.

Elevation and seasonal weather patterns in the study area combine to create a diverse vegetation pattern within a relatively small geographical area. Elevation ranges from under 4,400 feet to just over 7,900 feet on Mt. Hoffman. Winter storms approach the study area from the southwest, creating highly productive growing conditions from Pumice Stone Mountain to Black Mountain. At the same time, the area from Grouse Hill to Glass Mountain exceeds 7,000 feet in elevation and imposes a rain shadow over most of the area between Mt. Hoffman and the Lava Beds National Monument.

The interaction of climate, elevation and topography has produced two distinct timber types and three transition zones. A mixed-conifer zone exists between 4,400 and 5,800 feet. The dominant species are ponderosa pine, sugar pine, white fir and incense-cedar. The vegetation between 5,800 and 6,800 is predominantly red and white fir and is classified as being in the True Fir Type. Above 6,800 feet there are three different vegetation patterns that are more related to topography (cold air subsidence) than elevation. Nearly pure lodgepole pine stands occupy the flats and depressions. A mixture of lodgepole pine and red fir exists on slopes between 10 and 30 percent. On slopes greater than 30 percent the principal species are lodgepole pine, mountain hemlock and western white pine.

The size and age class distribution of the conifer vegetation is as varied as the species composition. Consequently, average volumes per acre for the various timber types and transition zones would probably not be valid for estimating the volumes derived from a well pad or a transmission line. Of greater significance is the productivity potential which ranges from a Dunning Class II in the southwest portion of the study area to small noncommercial sites scattered throughout the higher elevations.

A large portion of the proposed study area is currently covered by timber sale contracts and more are planned for the near future. Contracts usually include road construction or reconstruction, harvesting, slash disposal and road maintenance. The period of a contract may be up to five years and new contract term extension policies may lengthen this period. Following contract completion, cultural activities such as site preparation, reforestation and various thinnings take place. As a result of past silvicultural activities, plantations, thinned stands, and stands in stages of shelterwood harvesting are scattered throughout the lease area.

The following plant species is listed as sensitive by the Forest Service and is known to exist in the study area.

Penstemon cinicola - Two occurrences near Medicine Lake, one near Red Shale Butte, one near Grouse Hill and one near Little Glass Mountain have been documented to date. It also probably exists at the higher elevations.

## Socioeconomic Conditions

The area considered for geothermal leasing lies in northeastern California in the remote sections of eastern Siskiyou County, just west of Modoc County. The towns located within one hour driving time from the area generally have less than 300 residents depicting a very rural population. Two major population centers exist at two to three hours driving time in Redding, California, and Klamath Falls, Oregon.

The economy of these two counties is primarily based on agriculture, and the harvesting and manufacture of wood products. The current economic resources of the proposed lease area include timber, grazing, recreation, and cinder mining.

Temporary housing is abundant but currently located more than one hour driving time from the proposed lease area.

Local employment opportunities are mostly found in government, wood products manufacturing, retail trade, services, and agricultural sectors. In 1983, Siskiyou County had one of the highest unemployment rates in California, with 19.7 percent. Modoc County approximated the State's average unemployment rate with 10.6 percent. (Source: State of California, Employment Development Department, 1984.)

County governments, in this area, currently receive a substantial portion of their funds from National Forest receipts. Twenty-five percent of all funds collected from the sale of timber and forage for livestock grazing are returned to the counties based on the proportion of the county in a National Forest. Geothermal leases and royalties are another source of income for counties and the State. The State receives 50 percent of funds collected from geothermal leasing and production. Forty percent of the State's portion is then returned to the county where the funds were generated. Counties with geothermal resources are then able to apply for an additional 30 percent of the State's portion.

## Cultural Resources

Four categories of cultural resource sites are to be found within the study area: prehistoric, protohistoric, historic and modern Native American religious sites. The prehistoric sites probably represent the full range of hunter-gatherer activities including habitation sites, large and small animal kill and butchering sites, plant resource procurement and processing sites and the important lithic (chipped stone tool) raw material quarry sites located at the Grasshopper Flat and Glass Mountain obsidian flows. Hunter-gatherer occupation is thought to extend as far back in time as 5,000 B.C. (Hopkins 1983), however, an obsidian hydration dating chronology for this area has yet to be developed and thoroughly refined. Because the prehistoric sites in this particular part of northeastern California have not benefitted from a long period of professional study, cultural and artifactual analogies with more thoroughly studied areas like the Great Basin to the east, the coastal ranges to the west, the Upper Sacramento Valley to the south and the Klamath Lake cultures to the north, have been drawn. The information contained in sites within the study area has the potential to allow differentiation of those hunter-gatherer

survival strategies necessary for existence in the transition zone between the dissimilar environments exploited by the above-mentioned prehistoric cultures that have been used for comparison.

Protohistoric sites, those sites occupied by Native American peoples just prior to and after contact with intrusive European cultures, are also predicted to exist in the study area. Predominant occupation in the southern portion of the study area is thought to have been by the Atwamsini and Ajumawi bands of the loosely associated bands of the Pit River Tribe. The northern half of the study area was almost certainly occupied by Modoc bands. Limited resource exploitation by Shasta bands on the western periphery and by Wintu bands on the southern periphery of the study area is also likely. The opportunity to study culture change, from the prehistoric hunter-gatherer lifeway to entrance and assimilation into modern society, is a research value of these types of sites.

Historic period sites are also found in the study area. It is possible, although not yet documented, that fur trappers were the first Europeans to explore the area, a Hudson's Bay Company trapper's cabin has been recorded only a few miles west of the study area (Hart Timber Sale, ARR No. 445). Small farming and homesteading sites, as well as the possibility of early American military temporary camps and trails are also predicted. Sites associated with historic railroad logging activities will, however, comprise the most frequent type of historic site found within the study area. Although small gypo logging outfits were known to exist in the study area, the largest logging company, Weed-Long Bell, had the longest life and exerted a great deal of influence, socially and economically, on this area. Since the wood products industry still forms the economic base of northern California, information about the evolution of logging and lumbering technology, an industrial archaeological subject that has not received the study it deserves, is an important cultural resource.

The modern Native American peoples who have cultural traditions extending back to the prehistoric period, continue to use resources found in the study area in an effort to preserve their cultural identities. These resources not only include tangible materials such as food and ceremonial items but some natural features of the landscape have spiritual significance as well. These areas have not yet been completely recorded, nor are they likely ever to be. Some general areas of spiritual significance known to be of concern to local Native Americans include: Mt. Shasta, Black Fox Mountain, Little Black Fox Mountain, Medicine Lake, Medicine Mountain and various other peaks, mountains and springs. The American Indian Religious Freedom Act of 1979, requires ongoing consultation with local Native American organizations and individuals during all phases of land-surface altering activities for protection of the sites and areas important to the preservation of these cultural traditions.

Although no sites in the study area are currently on the National Register of Historic Places, many have been judged eligible and several are in the process of being nominated. Nomination and/or acceptance is, however, no obstacle to a site's removal by scientific excavation. Continuing cultural resource programs on a project-by-project basis on the McCloud District of the Shasta-Trinity National Forest, the Doublehead District of the Modoc National Forest and the Goosenest District of the Klamath National Forest inventory and protect sites as required by Federal law, regulation and policy. It has been estimated that 15%-20% of the study area has received

cultural resources examination in varying intensities in the past decade. It is generally felt that the site density, and thus the archaeological "sensitivity," of the study area is low. No map of known cultural resource sites will be provided. This information is on file at the respective National Forest offices and is available to the authorized public upon request.

## Noise

In general the ambient noise level in the proposed lease areas is low and typical of rural and open space areas. Natural noise sources include animals, wind, and occasional summer thunderstorms.

Machinery used in logging, mining, and ranching operations is sometimes audible in various localities. Recreational activities are sometimes accompanied by vehicular noise sources such as motorcycles and snowmobiles. No other industrial noise sources currently exist in the proposed lease areas.

## Transportation Systems

The study area is well accessed by existing paved and gravel-surfaced arterial roads, and gravel-surfaced collector roads. The primary access routes are:

1. Medicine Lake Highway (Modoc County Road 97), a paved two-lane arterial providing access from State Highway 139 to the east of the study area.

2. Powder Hill Road (43N49), a paved two-lane arterial providing access from State Highway 89 through the Shasta National Forest to the southwest of the study area. This arterial also connects with 42N24, an arterial providing access from Modoc County Road 91 to the southeast of the study area.

3. Lava Beds Monument Road (47N75), a partially paved, partially gravel-surfaced, primarily single-lane (with turnouts) arterial providing access from the Klamath Basin through the Lava Beds National Monument to the north of the study area.

4. Davis Road (45N05), a paved two-lane arterial providing access from Macdoel to the west side of the study area on the Klamath National Forest.

No additional construction or reconstruction of arterials and major collectors is projected within or to the study area.

## Range

Cattle grazing allotments exist on the entire Goosenest District portion of the study area. Two permittees graze approximately 1,200 head of cattle during the summer grazing season in the area. Water developments and fences are present throughout the area.

## ENVIRONMENTAL CONSEQUENCES

This section describes the potential impacts resulting from varying levels of geothermal exploration, development and production following leasing.

### ALTERNATIVE A - NO ACTION

There are no environmental consequences if the decision is made to not recommend further geothermal leasing on National Forest System land in the study area. Income to the Federal, State, and local county treasuries from geothermal development would be precluded. This could amount to approximately $100,000 per year annual rental plus a million or more in bonus bids at the time the leases are granted. In addition there would be royalties received when the production stage is reached. At that stage, property taxes paid to the county would amount to an estimated $2,000,000 per year. Fifty percent of the Federal receipts would be given to the State. The State of California, in turn, would pass some of the Federal geothermal receipts to Siskiyou County.

### ALTERNATIVE B - PROPOSED ACTION

#### Key Issue-Related Resources

#### Wildlife

Geothermal exploration is expected to create minor, temporary impacts on wildlife. These impacts include increased human disturbance and minor habitat modification. All of the management indicator species (MIS) could be potentially impacted in some manner.

Human disturbance is the major impact of exploration. Noise from drilling operations and road use could cause abandonment of goshawk nest sites, if the drill site was located within one-half mile of the nest. Human disturbance can also affect the use of traditional deer fawning sites. Increased road density may also increase deer harassment during hunting season.

Habitat modification is not expected to have a large impact on the MIS, if important wildlife habitat sites such as goshawk nests and old-growth stands are avoided.

Geothermal development and site occupancy have the potential to significantly impact wildlife and their habitats. Human disturbance and habitat modification will be the primary impacts. The projected impacts are listed for each MIS.

##### Mule Deer

Deer are relatively tolerant of human activities during most of the year. However, geothermal development will increase human activities significantly over present levels. Noise from drilling facility and

road construction, and operation of power plants will disturb deer use patterns. Deer fawning will be disrupted near these activities. Increased densities of roads open to the public will impact deer, especially during fawning and deer hunting season. Road kills along improved roads can be expected to increase due to increased public traffic. Illegal taking of deer will also increase due to increased public access and use.

Geothermal development may directly and indirectly affect about 600 to 900 acres of deer habitat. Well sites, power plants and roads will occupy approximately 100 acres. These habitats will be essentially lost. Up to another 300 acres could conceivably be in power transmission line corridors. These corridor acres will be in lower succession stage vegetation and may provide improved deer forage sites.

Steam transmission pipelines will be barriers to deer movement and migration, however, constructed overhead pipeline passes will allow deer movement. Pipelines may cause stress to deer during hunting season, as escape can be restricted. Wildlife water developments that accompany resource development will provide benefits to deer.

Overall, mule deer populations will probably be adversely affected by geothermal development.

Bald Eagle and Goshawk

Special Stipulation No. 2 in Alternative B restricts geothermal development in and near habitats occupied by these species. Development will probably not affect the identified MIS habitats, however, those sites not yet discovered can be heavily impacted.

Increased human use of the study area may increase disturbance of these species. Bald eagles forage at Medicine Lake and increased use could inhibit their foraging activities.

Powerlines have been documented to cause mortality of birds through collisions and electrocution. Properly designed powerlines can enhance habitat for birds of prey by providing hunting perches and protect them from electrocution (Olendorff et al., 1981).

Population levels for goshawks can be expected to remain stable to slightly decreased, dependent upon the level of development and mitigation. Bald eagle populations can be expected to remain stable.

Marten and Old-Growth Forests

Geothermal development could potentially affect marten populations. Power plants could provide enough disturbance to dislodge martens from their territories. Martens depend upon old-growth forests. Special Stipulation No. 2 prohibits development occupancy of designated old-growth stands. Occupancy adjacent to old-growth

stands could affect martens, though the direct impact on their population is not known and will be dependent upon the amount of development.

Snags

Geothermal development of 600 to 900 acres of forested area will remove these lands from the production and development of snags. The cumulative impact of geothermal development and current timber management activities is expected to be adverse to wildlife dependent upon snags. Loss of snags on these acres will occur.

Water Resources, Meadows and Fisheries

Special Stipulation No. 3 gives the Forest Service discretion in exploration and development activities near these resources. Impacts will probably be minor or nonexistent if regard is given to these resources during development.

Recreation

Activity associated with test drilling and production testing not only includes the physical impacts of land disturbance, but noise, dust, and contaminating impacts as well. The movement of men and equipment to and from test sites will have effects on traffic and recreational use.

The areas most affected by test drilling and testing operations would be the recreation management area. Since this area contains higher concentrations of developed sites and levels of dispersed use, conflicts would occur. Within this area fishermen, hikers, and picnickers would be disturbed and use would drop off, or be temporarily relocated.

Recreational users would be temporarily affected by noise, dust, traffic conflicts, or physical displacement from specific recreation use areas. Public safety concerns could restrict recreational use of an area until drilling operations cease. Potential contamination of streams and lakes could affect the fishery attraction.

Within the recreation management area, if located adjacent or close to the campground developments, direct conflicts with recreationists could occur. Noise from drilling operations, machinery, and traffic could destroy the serenity of these sites. The recreational experience sought by campground users would be temporarily affected (distracted). Use in these sites would temporarily drop and impact other areas, or these facilities would have to be closed to eliminate conflicts during testing. Night drilling operations would create irritating noise and light. Specific sites impacted by drilling operations would be off limits to public use. Dust generated by operations, trucks, and machinery would be distracting. Blowouts could affect campground use for an extended period.

Test drilling operations will also affect the dispersed recreationists using the area. Traffic conflicts will arise on roads used jointly by recreationists and drillers. The chance for accidents will increase. Drill sites will become attractions for sightseers, and certain roads may have to be restricted or closed to recreational use during drilling operations.

The quality of hunting will be degraded near drill sites operating during hunting season by possibly changing use patterns of the big game species being hunted and reducing the quality of the hunting experience for the hunter. Additional access roads will open new areas, increasing hunting pressure from hunters that were previously unwilling to hike into the area.

Some opportunities for other dispersed activities such as nature photography, exploring, gathering of forest products and hiking may be lost or displaced by drilling activities.

Roads built to access drill sites would be used by off-road vehicle users. Rehabilitated access roads would be subject to ORV use.

Winter drilling operations requiring plowed access roads may eliminate routes normally used by snowmobiles and cross-country skiers. At the same time these plowed roads may provide access to areas that are not currently used due to remoteness and inaccessibility

Drilling operations within seasonal road closure areas may require partial exceptions to the closure or establishment of corridors through the closed area to accommodate drilling. This may reduce the value of the road closure and encourage its violation.

Construction and development of a plant pipeline well complex within visual and noise impact distance of existing developed sites and campgrounds could make that site unusable during the construction and operation of the complex due to noise, dust, traffic, and unacceptable visual contrasts to the natural setting. At best, camping in Medicine, Hemlock, and Headquarters Campgrounds would be totally different experiences and could result in reduced use levels or closure of these sites. Because of their juxtaposition to Medicine Lake and lack of other lakes or streams in the area, their use could not be provided for elsewhere.

Developments that could not be screened visually or muffled so as not to be heard in a distracting manner from the developed recreation sites could mean permanent closure and loss of use of these facilities.

Natural attractions could be impaired by construction and development so as to lose their recreational appeal. On the other hand, geothermal production could become an attraction itself.

Pipelines between production wells and generating plants would be obstructions to hikers, horseback riders, ORV users and cross-country skiers. These facilities may reduce the amount of land available for these activities or reduce the number of people participating in the area. Powerlines along recreation oriented roads would detract from the sightseeing experience.

Any contamination of the water could eliminate or reduce the fishery in the lakes, thereby reducing their recreational value.

Development adjacent to the Lava Beds National Monument may detract from the scenic, wilderness, and interpretive values associated with the Monument. Changes in air quality, noise levels, and amount of human activity from developments near the Monument boundary may be noticeable within the park and detract from the natural aspect that is maintained there.

Visual Resources

The visibility of the test drilling will vary, depending on the type of equipment used, the location of the test site and the key viewpoints from which the operation is viewed. Larger drill rigs used for deeper holes will be visible for longer distances and could exceed the height of the surrounding tree cover. Clearings and grading on steep slopes will be much more visible than those on the flatter slopes. Drill rigs located in open country would be visible for many miles for the duration of the drilling operation.

Visibility of drilling operations and the degree of visual impairment on the scenic resource will be determined by how close or obtrusive the operations seem to viewers at key viewpoints. Drilling operations taking place in the foreground zones of key recreationally used highways and roads will likely not meet Visual Quality Objectives as the drilling operations and equipment will not draw from the surrounding landscape character or setting of the area. These road corridors include the Black Mountain-Tionesta Road, Medicine Lake Road, Powder Hill Road and Davis Road.

Other key viewpoints include the foreground zones around developed recreation sites and concentrated dispersed recreation use zones. The foreground zone will vary in width, but it usually includes all lands seen within 0-3/8 mile of these sites. It may extend farther in some cases. These foreground zones for roads and recreation sites carry a Visual Quality Objective of Retention. This means that impacts must not be visually evident to the casual observer, if the objective is to be met. These include Medicine Campground, Hemlock Campground, Headquarters Campground, Medicine Lake Beach, the dispersed recreation zones around Payne Springs, Blanch Lake and Bullseye Lake, and the private resort area on the southeast and northwest ends of Medicine Lake.

Test drilling and related access road construction will be visible in middleground and background views from the key viewpoints identified above when operations are located in open areas, on steep slopes or ridge lines. Operations might not achieve the Visual Quality Objectives (VQOs) in these situations during the drilling period. VQOs could be achieved in most other situations in these view zones and in many foreground zones after drilling operations cease and the sites are restored although impacts from access road construction on steep slopes may be difficult to visually rehabilitate.

The key viewpoints from which plant development will be seen are the same as those identified for test drilling. Any plant or well development within the foreground zones of key recreationally traveled roads, recreation sites or within concentrated recreation use zones would be visually incompatible with the surrounding landscapes. The facility would dominate the view and would not be compatible with the surrounding natural setting. The closeness and magnitude, plus the high structural complexity of the facility, will preclude the opportunity to draw from natural characteristics in terms of form, line, color or texture. The plant will appear as an industrial complex out of context with the surroundings. Its overpowering impact would negate any beneficial views of background zones. Visual quality objectives would not be met. Screening efforts and mitigations will not be effective. It may also not be possible for powerlines to meet established visual quality objectives, depending on the location, size of lines, and corridors.

The plant, pipeline, and well site complex, if located in middleground (usually 3/8-4 miles), and background (4+ miles) zones, as seen from key viewpoints, will be less visible and more compatible with the surrounding landscape. Development in gentle slope-timbered zones could be effectively screened and meet the visual quality objectives established for the area. Opportunities to mitigate through design, location of facilities, color and shape could be available and effective.

Powerlines located in middleground and background zones may be visible, depending on alignment and the observer's position. Corridors carrying multiple lines may be visually prominent and difficult to screen. Location and alignment of corridors relative to key viewpoints would be critical.

Highly sensitive areas for plant, pipeline and well development, as seen in middleground and background zones would be open areas, steep slopes and ridge lines. These same areas will also be visually sensitive for road or powerline construction. Plant and well units located in middleground and background zones may be completely screened from some key viewpoints but not others. Steam plumes from cooling towers at plant locations can rise above 250 feet in the air. The cooling towers can exceed 150 feet in height and the steam resulting from these towers can rise more than 100 feet on cool days with minimal winds. Warmer temperatures and increased winds will greatly reduce the amount the steam rises above the towers. Steam plumes will rise above vegetative barriers that may be screening plants and in many cases the topographic barriers that may be providing visual screening from distant viewpoints. Steam plumes could be visible from key viewpoints within the KGRA depending on the location of the plants relative to the viewpoint. Also steam plumes may be visible from the Lava Beds National Monuments in middleground and background views if plants are located in the northern half of the KGRA. During those times when steam plumes are visible from the key viewpoints they will appear out of context from the natural landscape and will distract from the scenic qualities in those areas.

Climate and Air Quality

Temporary impacts to air quality would occur from fugitive dust created by road and other facility construction activities. There would also be increased emissions from diesel and gasoline equipment. These emissions could combine with oxidants increasing local nitrogen dioxide levels.

During the geothermal development and production the following impacts to Air Quality may occur:

1) Visibility degradation from increased particulate loading of the atmosphere.

2) Odor from increased ambient air concentrations of hydrogen sulfide.

3) Increased ambient air concentrations of other noncondensible gases and chemical elements, e.g., ammonia ($NH_3$), methane ($CH_4$), mercury (Hg), radon (Rn), carbon dioxide ($CO_2$), arsenic (As), and boron (B).

4. Increased cloudiness, fog, precipitation and highway icing from water vapor emissions.

Several unique characteristics of the study area are important in evaluating or determining acceptable air quality changes. The study area is used for outdoor recreation, both in summer and winter. Because this use depends in part on the excellent visibility and air quality presently existing, there is concern that construction and development of a geothermal industry in the study area would have an adverse impact on this land use. Construction activities are frequently large sources of airborne dust. Because of the very dry conditions and sparse vegetation existing in this area, the soil is particularly susceptible to this type of disturbance. Second, the elevation of the entire KGRA is above 6,000 feet. In winter the area is subject to very low temperatures, so that even small releases of water vapor could lead to local or temporary enhancement of cloudiness, highway icing, precipitation, and fog. Emitted hydrogen sulfide has the potential to be transformed into sulfate particles in the atmosphere, and such particles are usually of sizes that are particularly effective in reducing visibility. However, the transformation of $H_2S$ into sulfate particles is expected to be low and not to produce a major effect.

Hydrogen sulfide from geothermal wells and power plants has the potential of being an odor nuisance in inhabited areas from time to time. Currently, the geothermal emission standard for hydrogen sulfide is 2.5 kg/hr/well.

Emissions of other substances (e.g., heavy metals) have the potential for adversely affecting nearby flora and fauna, either by increasing ambient air concentration or by direct deposition.

Water

After initial surface geological, geophysical, and temperature gradient data indicate a prospect is attractive, deep exploratory drilling is conducted. Exploratory drilling is the first major water use of a geothermal project.

Exploratory drilling is composed of the construction of a well-pad and access road, temporary erection of a drilling rig and ancillary equipment on the pad, drilling the well, and finally testing the well. Only the drilling phase consumes any large amount of water. Drilling a deep (greater than 4,000 feet) geothermal well requires approximately 1 to 4 acre-feet of water depending upon subsurface drilling conditions (average 2 acre-feet/well).

When the well is drilled, drilling mud is used to cool and lubricate the bit and to remove cuttings from the hole. Mud is a mixture of water and clay. The water for early exploratory wells usually is purchased and trucked to the drill site or is drawn from nearby wells under permit.

Exploratory wells drilled to date in the study area have utilized water purchased from the Forest Service. If necessary, water could be purchased and trucked from the nearest point of adequate supply. If a significant amount of drilling is anticipated, it may be advantageous to drill a water well. Later development wells normally utilize geothermal condensate from a power plant for mixing drilling mud (Ecoview 1975).

The drilling sumps are constructed and operated according to regulations of the California Regional Water Quality Control Board. During drilling, water, mud, and drill cuttings are discharged to the sump which is lined with an impermeable material to prevent losses. Water is recirculated from the sump to the drilling mud system as a conservation measure. Heavy rains may mean that excess water which collects in the sump must be trucked to an approved dumpsite or pumped into an injection well. After completion of the well the sump contents are solar dried if possible, mixed with native soils, and buried in the sump, or are hauled by truck to an approved dump site.

If several exploratory wells tap a developable geothermal resource, a power project is proposed. Such a project is often about 25-50 megawatts (MW) generating capacity. Large reservoirs would be exploited in increments of 50 MW and would consume proportionately more water.

The initial development stage involves power plant, pipeline, and separator construction, as well as initial production and injection well drilling. This stage is followed by roughly 30 years of periodically drilling "make-up" wells to keep production at start-up rates as the wells age and individual well production declines. Make-up well drilling of 10 wells at 2 acre-feet per well will consume about 20 acre-feet of water.

Construction of a 25- to 50-MW power plant consumes about 20 acre-feet of water (Ecoview 1975) for such purposes as dust control, concrete mixing, wetting foundation material, washdown water, and initial filling of cooling tower basins (California Energy Commission 1982). These uses occur only once. Well water usually is the supply source.

Once the project is constructed and a normal operating mode is attained in conventional plants, no outside source of water is expected to be needed in the Glass Mountain area (except for less than 2 acre-feet per year per 50-MW project for domestic uses such as wash water and toilets (California Energy Commission 1982). Geothermal power projects produce their own condensed geothermal steam (or "condensate") which is used for cooling. Figure 1 shows how this condensate originates.

The meteorology of the Glass Mountain area is characterized by cold winters, cool to moderate summers, and low humidity. These conditions provide good cooling for geothermal projects. Conventional geothermal projects exhaust unusable heat by evaporating water in "wet" cooling towers. Calculations using current assumptions about the reservoir and fluid characteristics show that during one year of operating in the Mono-Long Valley area, a 50-MW power project would be expected to evaporate about 1550 acre-feet of cooling fluid from its cooling towers. This amounts to about 10% of the fluid removed from the reservoir to power that same 50-MW plant. Because of lack of hydrologic data for the Glass Mountain area, a 50-MW power plant project is assumed to consume about the same amount of water. If air-cooled towers were used (similar to the radiator in an automobile) there would be no evaporation loss of cooling fluid and virtually 100% of the fluids drawn from the reservoir could be reinjected. Ground subsidence due to removal of 10% of the fluid is expected to be little or none because the reservoir rocks are structurally supported.

If all of the cooling fluid is drawn from surface waters or if dry cooling is employed, virtually 100% of the geothermal fluid could be reinjected. Because geothermal condensate will most surely be used for cooling, the above comparative values are high.

Figure 1 shows that in the expected mode of operation less than 100% of the geothermal production would be injected back into the underground geothermal reservoir. It is impossible to tell at this point whether geothermal operations which result in injection of less than 100% could significantly affect the surface waters of the Glass Mountain area.

Deep exploratory wells will provide specific data to more accurately analyze and predict effects on subsurface hydrology, and thermal and nonthermal surface waters. The exploration phase of this project is therefore essential to answering the questions regarding impacts of development. Exploration will yield necessary information on temperatures, pressures, and fluid characteristics at depths which are currently only speculation. Information on rock types, permeability, and porosity will also be acquired by deep exploratory drilling, thus adding substance to current hypotheses and models.

As discussed earlier, geothermal development generally takes place over several years. Water use is, therefore, spread out over time.

Table 8 shows the water consumption of a 50-MW power plant. Table 9 shows the water consumption of a 550-MW developed field.

Due to clearing of test pads, there would be a negligible increase in runoff which will be absorbed in nondisturbed areas.

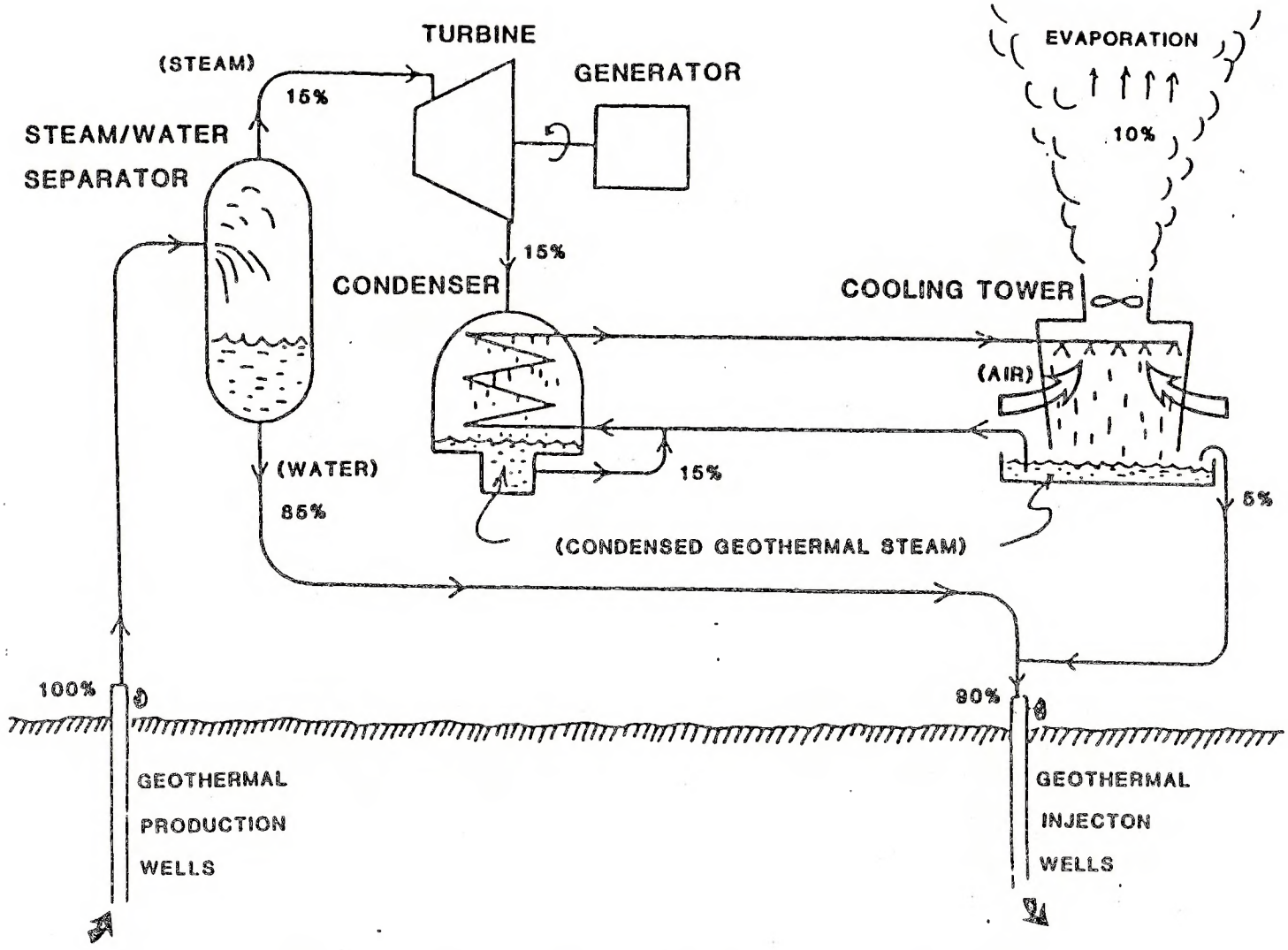



**FIGURE 1- WATER BALANCE FOR A GEOTHERMAL PROJECT**
**(Flows are indicated as percent of production)**

TABLE 8. ESTIMATED WATER CONSUMPTION FOR A 50-MW POWER PROJECT

| Activity | Acre-Feet |
|---|---|
| Drill 10 exploratory wells - 2 acre-feet (AF) each | 20 |
| Drill 20 initial production/injection wells (2 AF each) | 40 |
| Construction of a 50-MW power project: | 20 |
| During 30-year life drilling 10 more production/injection wells (2 AF each) | 20 |
| Domestic water use for 30 years - 2 AF/year | 60 |
| 30-Year Total | 160 |

Operate 50-MW power project (with conventional wet cooling):

900,000 lb steam/hour x 67% average evaporation
x 0.01603 cubic feet/pound x 7000 hours/year
x $2.296 \times 10^{-5}$ AF/cubic feet = 1550 AF/year [2/] lost to evaporation

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[2/] Since geothermal condensate (from condensed steam) would be the cooling fluid for conventional wet cooling systems, no surface waters would be consumed by operation of the project.

TABLE 9. ESTIMATED WATER CONSUMPTION FOR FULL DEVELOPMENT

Based on Table 4, and noting that after the first 50 MW is discovered, usually fewer exploratory wells are required to confirm the next 50 MW. Also, geothermal condensate is used to drill production wells once a power plant is available as a source of condensate. The estimates of water consumption are as follows:

| | Acre-Feet of Water |
|---|---|
| | Most Probable Case - 550 MW |
| Drill 10 exploratory wells (first 50 MW)(2 AF/well) | 20 |
| Drill 15 subsequent exploration wells (2 AF/well) | 30 |
| Drill 20 initial production/injection wells | 40 |
| Construct power projects, 11 50-MW projects at 20 AF/project | 220 |
| 30 years domestic water use (8 AF/year) | 240 |
| 30-YEAR TOTAL | 550* |

* Most of this total would be spread over a period of approximately 7 to more than 30 years.

Accidental puncturing of an aquifer during drilling or fracturing of bedrock during active seismic testing could cause ground water movement or mixing. While unlikely, such accidents could potentially cause fluctuations in quantity, chemical content, or temperature of spring or stream flows.

Water quality degradation by sedimentation, changes in pH, etc., associated with an accidental discharge of drilling wastes could occur on a local basis. Test sites would not be permitted within 700 feet of water sources listed in the affected environmental section to avoid degradation of surface water quality.

### Geological Features

Implementation of Special Stipulation No. 1 would eliminate or minimize surface disturbance of impacts to the geological features in the study area.

If development occurs on the steep-sided volcanic slopes, down-slope movement of rock and soil may occur.

If a developable resource is discovered and if its development would require impacts to these geological features, the relative values of these geological features and the geothermal resource would be analyzed through the NEPA process.

### Lava Beds National Monument

The Lava Beds National Monument will not be directly affected by geothermal development. There will be no land occupancy or use of roads within the Monument.

Consequences that might be observed by the public from some of the higher points in the Monument would be a visual impact resulting from operations off of the Monument. There is a very low probability that air quality in the Monument will be affected from time to time. It is anticipated that mitigation measures and requirements for geothermal operations will not allow enough pollutant to escape into the air to have an on-site impact. Sounds emanating from drilling operations are of a short-term nature and not likely to detract from enjoyment of the Monument to any great degree.

## Other Resources

### Timber and Other Vegetation

Based upon a potential of 10 55-MW power plants in the study area, it is estimated that a minimum of 470 acres would be removed from timber production for at least 30 years. If injection wells are needed, that area would expand to approximately 560 acres. It is estimated that the true area impacted could be 10 to 30 percent greater because previously designed management units would be dissected, thereby creating unmanageable areas. Based upon this estimation a loss of 730 acres of timber production

would occur. This land area does not include a transmission line corridor necessary to move power from the plant to the nearest interstate transmission line. From the west side of the study area to the transmission line west of Tionesta, the area involved would be approximately 335 acres (23 miles X 120 feet). The transmission line area added to the power plant acreage equals 1,065 acres or slightly less than one percent of the total forested land. A loss of 1.0 percent of the land base for one-fourth of a rotation represents a loss of 20-25 MMBF in the initial clearing plus 400 bf/ac/year in growth. This position is based upon the premise that the lessee would be required to reforest the affected area.

It is possible that some areas of high investment such as plantations and timber stand improvement work will be lost. These investments currently range from $50 to $400 per acre. Even if the lessee were to reforest the area at their expense, there would be some loss of the government's investment.

A potential for conflict exists between timber purchasers holding valid contracts and a lessee wanting to develop a site. Also, future timber sale contracts will necessitate additional improvement protection clauses and on-the-ground administration time.

Field development is likely to cause potential timber sales to be replanned and possibly delayed with a probable increase in the cost of preparing and selling timber.

The existence of Penstemon cinicola near Little Glass Mountain (SE¼, S.14 T.43N., R.2E.) is the only known occurrence within the competitive lease parcels. Disturbance of this sensitive species is unlikely as the lessee is required to inventory potential field development and production sites for sensitive plants.

Socioeconomic Conditions

Aerial and surface surveys, and thermal gradient hole drilling would probably not affect local population or employment conditions. Most of the personnel would be imported to do this work and normally exploration would not last over an extended period of time.

During exploration, the public's attitudes could become positive or negative depending on the perceived effects of geothermal leasing. Attitudes would tend to be focused on exploration activities adjacent to or in the Medicine Lake vicinity, and Lava Beds National Monument. The concern would be that physical and biological values are protected from other than temporary disturbances and that no long-term consequences will occur.

During the development phase, when production wells would be drilled and power plants constructed, employment would fluctuate between 20 and 400 people directly employed. The development phase would begin at about the fifth year following leasing and continue through the seventeenth. Much of the labor would come from outside the area, particularly for very specialized skills. The level of employment would fluctuate with the

stage of power plant construction in progress. Maximum employment would probably occur during the summer months when weather conditions are most favorable for construction work.

Since much of the employment would go to people presently living outside of this area, a demand for housing would result. Most employees would seek temporary housing. Currently there is abundant temporary housing available at all times of the year, yet it is located one and one-half to two hours driving time distance. There is practically no temporary housing available within a driving time of less than one hour. Improved roads would make existing communities to the north and west of the proposed area more accessible. Without improved roads, construction of nearer temporary housing for the development phase may be necessary. The need for permanent housing generated by geothermal development could possibly be absorbed in the existing housing market.

During development, public attitudes will be concerned with placement of the production wells and power plants due to the possible long-term effects on physical and biological values. The area has high use for all types of recreational activities especially deer hunting, throughout the area, and water-based activities on Medicine Lake. A benefit of development would make the area more accessible for winter recreational activities with winter road maintenance.

During the operation phase 40 to 200 people would be employed. Most of these positions would be permanent. This work force would be phased in as the power plants are completed. The operation work force would be smaller than the development work force resulting in a net decline in housing demand. The effect on the economy of this decline would be small. Most of the reduction in housing demands would be in temporary housing.

Revenue to the Federal government from geothermal leasing is $2 per acre per year for competitive leases and $1 per acre per year for noncompetitive leases. An estimate made during analysis for geothermal development in Imperial County, California, in 1979, indicated that the county could expect $5,000 in tax revenues per megawatt of generated capacity from an operating geothermal electric power generation plant. Since most utilities are in the same economic category and industrial taxes have not risen appreciably, this may be a reasonable estimate of tax income to Siskiyou County, should energy development take place. Similarly, the State currently receives about 50 percent of all royalties collected by the Federal government from producing mineral leases.

Overall, there are no negative economic effects predicted from geothermal leasing in the proposed area. The estimated project size is small and therefore would not create the negative impacts that have been associated with fossil fuel developments. The small project size is also not predicted to cause negative impacts on the area's social structure.

### Cultural Resources

Any ground surface-disturbing activity within the boundaries of a prehistoric, protohistoric or historic site will disturb and/or destroy the patterning of surface and subsurface artifacts and features from which

archaeologists infer past human behavior and construct a record of past human lifeways. Any landscape altering activities have the potential to adversely affect the spiritual significance of natural features important to Native American groups.

## Noise

The geothermal reservoirs in the Glass Mountain KGRA are liquid-dominated and no venting of superheated steam should occur. Wells could be shut-in when not producing, eliminating the need to release geothermal fluid. No venting should be necessary when wells are put back into production. Liquid-dominated geothermal fields can, therefore, be developed and operated without the problem of very high noise emissions. Major noise sources should not exceed 95 dB(A) at 15.2 m (50 ft) and standard noise control measures are available for these sources (Strojan and Romney 1979).

A summary of noise sources expected to accompany geothermal resource development in the lease area is given below, along with typical sound pressure level (SPL) ranges.

1. Road and Site Preparation--Especially during the exploration and field development stages, heavy earth-moving equipment is used to prepare roads, drill pads, sumps, and sites for the power plant and other facilities. Data from the EPA document PB 206 717 suggest a SPL range of 7-95 dB(A) at 15.2 m (50 ft) (U.S. Environmental Protection Agency 1971a).

2. Well Drilling--Drilling operations begin with exploration and continue through the field development stage. Make-up wells must be drilled periodically during the production stage to replace the original wells whose yield has declined. The dominant noise sources associated with drilling are the large diesel engines which power the rotary rig and mud pumps. Typical SPL during drilling when mud is used as the circulating medium ranges from 75-85 dB(A) at 15.2 m (50 ft) (Whitescarver 1978). SPL of about 62 dB(A) was measured at 182.4 m (200 yd) from a large rotary drill rig (Fraser-Smith 1977).

3. Production Testing--The process of flowing geothermal wells to test production capability begins in the exploration stage and will occur periodically for the life of the field as new make-up wells are drilled. Data from Imperial Valley in California suggest that SPL during this operation should be below 90 dB(A) at 15.2 m (50 ft) (P. Leitner, unpublished data).

4. Facilities Construction--Construction of a power plant, pipelines, and transmission lines involves the use of many standard pieces of heavy motorized equipment. The resulting SPL can be estimated at 70-95 dB(A) at 15.2 m (50 ft) by reference to the EPA document PB 206 717 (U.S. Environmental Protection Agency 1971a).

5. Operation of Geothermal Field and Power Plant--The noise emission characteristics of geothermal power plants, including turbine building, cooling tower, and steam jet ejector system, are well documented, and adequate data are readily available. SPL of 75-85 dB(A) are typical

at 15.2 m (50 ft) from the cooling tower, the dominant noise source (Bush 1977). Other potential noise sources are the flash units in which a portion of the geothermal fluid is allowed to flash to steam. These units may be located at the well heads or near the turbine building, although the exact design will depend on the electric generation technology used. SPL at 15.2 m (50 ft) from a flash unit undergoing testing in Imperial Valley was measured at 85 dB(A) (P. Leitner, unpublished data). Downhole pumps required to produce the geothermal fluid and reinjection pumps used to dispose of residual liquids should be powered by electric motors; these motors are not expected to be major noise sources.

6. Vehicular Traffic--Auto and truck traffic is an important source of noise throughout the life of any geothermal project, with maximum SPL ranging from 70-95 dB(A) at 15.2 m (50 ft) depending on the type of vehicle (U.S. Environmental Protection Agency 1971b).

Transportation Systems

The roads described in the Affected Environment section have been designed and constructed for timber haul, recreation and administrative use with the following exception: Lava Beds Monument Road within the National Monument boundaries cannot be utilized by other than light recreation and administrative traffic--the restriction is based upon National Park Service traffic management policy. An exception to this policy for geothermal development needs would not be expected.

It is projected that winter access and concurrent snow removal will be limited to County Road 97. This will permit winter recreationists access to the Medicine Lake Caldera, significantly increasing recreation traffic and parking on National Forest land, and also increasing traffic to the private tracts adjacent to Medicine Lake itself. The specific recreation activities expected would be cross-country skiing, snowmobiling, ice fishing and snow play.

During spring runoff, it is projected the snow plowing activities will channelize runoff causing erosion damage to road shoulders, ditches, fills, etc., not presently so affected.

Based on the most likely development level of 550 MW, some 10 to 15 miles of local roads (see Table 2) will be necessary. While use of existing low standard road wherever possible would be emphasized, it is probable at least 8-10 miles of new local roads would be constructed resulting in 50+ acres of surface disturbance for road access alone. Other site specific impacts would have to be evaluated and mitigated as specific alignments are identified and agreed upon to meet mutual road access needs.

Range

Geothermal activities could have a disruptive impact on grazing use in the area. Construction of new roads could increase the chance of cattle drifting from one allotment to another unless measures are taken to prevent it. The presence of pipelines and other facilities could disrupt normal use of the area and also decrease the amount of available forage.

ALTERNATIVE C - LEASE WITH THE EXCEPTION OF SENSITIVE AREAS

Alternative C will be the same as Alternative B except the areas shown on Map 5 will not be leased. This will exclude about 16,000 acres, and could potentially reduce the production rate by 30% or 165 MW. This would also reduce the County revenue by 30% or $825,000 per year.

## MITIGATING MEASURES

Measures required to mitigate environmental impacts of the proposed geothermal development are listed below. Each impact is described along with the mitigation measure designed to reduce the effect. An estimate of the effectiveness of each mitigation measure is then presented.

Analyses such as this generally lead to two major types of mitigation; measures which will become lease stipulations and measures which will be followed at the plan of operation stage. In this analysis most potential lease stipulations are "up front" as Special Stipulations that are part of the proposed action (see pages 13 and 14). The mitigation measure (see top of page 51) that will become a lease stipulation is identified by an "(L.S.)" after its description. The remainder of the measures will be incorporated as appropriate at the plan of operation stage.

| IMPACT | MITIGATION MEASURE | EFFECTIVENESS |
|---|---|---|
| Wildlife | | |
| 1. Loss of habitat due to road and power plant construction. | Snags, water developments, and deer habitat manipulation will be required to offset habitat losses. | 80-90% effective. |
| 2. Increased human presence due to roads and activity and increased density of roads. | Continue to manage limited access areas. Consider closing roads. | 80-90% effective. |
| 3. Obstruction of mule deer movements. | Plan pipeline construction to allow free movement of deer between and on their seasonal ranges. | Unknown |
| 4. Increased road kill of deer. | Design new roads for lower speed travel, post adequate warnings for deer and speed limits. | Unknown |
| 5. Mortality to birds transmission lines. | Design transmission lines to prevent raptor electrication. | 95% effective. |

| IMPACT | MITIGATION MEASURE | EFFECTIVENESS |
|---|---|---|
| Visual Resources | | |
| 1. Drilling impacts could exceed the Visual Quality Objectives along identified travel routes and use areas. Travel routes include: Davis Rd., Powder Hill Rd., Medicine Lake Rd., Medicine Lake Highway (Black Mtn.-Tionesta Rd.), Fourmile Hill Rd., Monument Headquarters Rd., and Monument Rd. Use areas include: Medicine Lake developed recreation sites including private developments and the dispersed recreation areas at Payne Springs, Bullseye Lake and Blanche Lake. Development and construction of well sites, pipelines, plant sites, or power lines could be intrusive and incompatible with the VQOs as viewed from identified travel routes and use areas. | Special Stipulation No. 1 (see p. 13) shall apply to foreground zones of the identified travel routes and use areas. (L.S.)<br><br>Provide for location and design of development and construction of facilities to achieve VQOs in middleground and background zones.<br><br>Rehabilitate all disturbed areas to meet Retention Visual Quality Objectives. | Scenic quality along key travel routes and adjacent to recreation use areas will be maintained. |
| 2. Development, construction and drilling operations may be highly visible from distant viewpoints if located on steep slopes, open areas or ridgelines and may exceed the Visual Quality Objective. | Avoid locating operations in highly visible locations including steep slopes, open areas or ridgelines. | Development, construction, and drilling operations will appear as subtle deviations in middleground and background views. |

| IMPACT | MITIGATION MEASURE | EFFECTIVENESS |
|---|---|---|
| Air Quality | | |
| 1. Increased ambient air concentrations of other noncondensible gases and chemical elements will result. | Require abatement to meet applicable Federal, State or regional air quality standards. | 95-100% effective. |
| 2. Increased releases of sulfur compounds will result. | Require abatement to meet applicable Federal, State or regional air quality standards. | 95-100% effective. |
| 3. Temporary increase in dust and total suspended particulates in the atmosphere will result. | Require appropriate treatment of roads and all disturbed areas. | 100% effective. |
| Water | | |
| 1. Increased sediment loads and turbidities in surface waters. | Conform to Best Management Practices for Water Quality Management on National Forest System Lands. Specifically 2.1-2.28, Road and Building Site Construction; 5.1-5.5, Vegetative Manipulation; 6.4-6.6, Fire Suppression; 7.1-7.7, Watershed Management. Other Best Management Practices may be required as identified in future environmental analyses. | 90% effective. |
| 2. Potential pollution of groundwater. | Restore water quality to meet beneficial uses. | 80% effective. |
| | Follow waste discharge requirement established by the California Regional Water Quality Control Board, Central Valley and North Coast Regions. | 95% effective. |
| 3. Contamination of aquifers. | A surface seal of 40 feet shall be required on all water wells. | 55% effective. |
| | Drilling operations will meet Water Quality Control Board standards. | |

| IMPACT | MITIGATION MEASURE | EFFECTIVENESS |
|---|---|---|
| Water (Continued) | | |
| 4. Ground water depletion. | Monitoring programs may be required for groundwater levels and temperature. | Variable. |
| Timber and Other Vegetation | | |
| 1. Disturbance to sensitive plants. | Require lessee to inventory sites prior to any major surface disturbance. | 95% effective. |
| 2. Taking production land out of production. | Locate well pads, power plants and pipelines on noncommercial land or least productive sites whenever possible. Clearing for pipeline and power lines will be kept to a minimum. | 70% effective. |
| 3. Resource use conflicts between a timber sale purchaser and a lessee. | Avoid field development until the timber sale contract is closed. | 100% effective. |
| | Relocate pipelines and power lines when no other alternatives for timber harvesting are available. | 80% effective. |
| | Coordinate geothermal development needs with timber needs prior to construction. | 80% effective. |
| Cultural Resources | | |
| 1. Destruction of the patterning of surface and subsurface artifacts and features from which past human lifeways may be inferred. | Archaeological survey of the areas to be impacted immediately before activity takes place. | 50% effective. |
| 2. Adverse effect on spiritual significance of landscape features. | Consultation with local Native American groups. | 100% effective. |

| IMPACT | MITIGATION MEASURE | EFFECTIVENESS |
|---|---|---|
| Noise | | |
| 1. High noise levels due to road and facilities construction, drilling operations, production well testing, and operation of the power plant and geothermal field. | Comply with GRO Order No. 4, Section II (Noise Abatement) and 43 CFR 3262.6-1. | 100% effective to obtain legal levels. |
| Range | | |
| 1. Increased cattle drift resulting from new road construction. | Construct cattleguards at all fence crossings on main access roads; gates at crossings on temporary roads. | 95-100% effective. |
| 2. Loss of forage due to road and facility construction. | Locate roads and facilities on least productive lands whenever possible. | 70% effective. |

## UNAVOIDABLE ADVERSE IMPACTS

Based on the environmental consequences predicted and the mitigation measures proposed, the following unavoidable adverse impacts are expected from the proposed action.

### WILDLIFE

Habitat losses will occur in spite of mitigation attempts. Such losses will not displace or significantly reduce wildlife populations. Road kills of deer will increase an estimated 10% above present levels, primarily on roads off-site due to increased traffic on arterial routes. Minor disturbance will have a negligible impact on raptors in the area. Nest abandonments are not expected.

### RECREATION

Minor inconveniences through increased traffic and occasional noise intrusion will diminish the recreational experience in the Medicine Lake Caldera and to a lesser extent in the remainder of the study area.

### VISUAL RESOURCES

Visual resources within the key foreground zones will be impacted by temporary exploration wells. However, the impact will be very localized and temporary. Middleground zones will receive slight disturbance and minor surface disturbance will be apparent where camouflage, screening, and other techniques fail to totally mask the location of facilities or the effects of exploration and development.

Background views will suffer moderate localized impacts where design principles which use color, line, form and texture do not fully mask facilities.

Middleground zones will suffer moderate intrusion and visual quality reductions. Plants, power lines, pipelines and roads will be an intrusion on a varied and picturesque landscape.

Water vapor plumes would be a visual intrusion especially if power plants are sited in the northern portions of the KGRA. The plumes would be visible to visitors to the Lava Beds National Monument. The presence of such plumes is not expected to result in reduced visitation to the Monument.

### AIR QUALITY

There will be some increased releases of noncondensible gases and chemical elements including sulfur compounds on an infrequent short-term basis.

WATER

A minor potential for pollution of surface and groundwater exists from infrequent, temporary events which may exceed legal discharge limits. Stream flows and surface waters will not be significantly impacted.

TIMBER AND OTHER VEGETATION

A minimum of 1,065 acres would be removed from timber production. An extensive investment in timber stand improvement and plantation would be lost. Conflicts between timber purchasers and geothermal developers will increase timber administration costs.

CULTURAL RESOURCES

It is possible that geothermal development will alter the character of the landscape, or certain features of the landscape, to such an extent as to adversely affect those tangible and intangible qualities that Native American groups feel are of spiritual significance. Continuous consultation with Native American groups throughout all phases of the development process, from exploration through design and actual development, may succeed in minimizing such conflicts.

RANGE

Forage losses will occur in spite of mitigation attempts. These losses should not result in a reduction of permitted numbers of cattle using the area.

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REFERENCES CITED

Airola. 1982.

Anderson, Charles A., 1941. Volcanoes of the Medicine Lake Highland, California. University of California Press, Vol. 25, No. 7, p. 347-422.

Brook, C.A., R. Mariner, D. Mabey, J. Swanson, M. Guffanti, and L. Muffler. 1979. Hydrothermal convection systems with reservoir temperatures greater than or equal to 90°C, in Muffler, L.H.P., ed., Assessment of Geothermal Resources of the United States--1978. U.S. Geological Survey Circular 790, 163 pp.

Bush, R.C. 1977. Plant and equipment noise treatment. Pacific Coast Electrical Association Engineering and Operating Conference, March 17-18, 1977, Los Angeles, California.

California Department of Fish and Game. 1976. The fish and wildlife resources of the Klamath Basin, Lava Beds, Medicine Lake Highlands planning unit and recommendations for their protection. California Department of Fish and Game, Region I.

California Department of Water Resources. 1982. California Water Atlas.

California Energy Commission. 1982. Cumulative impacts study of The Geysers KGRA - public service impacts of geothermal development. July.

Camilleri, E. 1982. Fish and wildlife habitat capability models and special habitat criteria for the Northeast Zone National Forests - goshawks. Forest Service - USDA, Region 5.

Clark, M.D. 1979-1983. Water resource data for Mammoth Ranger District, USDA, Inyo National Forest.

DiPippo, R., 1980. Geothermal energy as a source of electricity. U.S. Dept. of Energy, Division of Geothermal Energy, Contract No. AS02-76ET28320, 320 pp.

Ecoview, Inc. 1975. Geysers leasehold EIR.

Fitzsimmons, Clairemarie. 1981. An Archaeological Reconnaissance of the Hart Timber Sale. ARR 05-05-445. Klamath National Forest, Yreka.

Fraser-Smith, E.B. 1977. The effect of drilling a geothermal well on the behavior and reproduction of sage grouse. Prepared for Republic Geothermal, Inc., by Enviros, Los Altos, California.

Gates, Gerald R. 1982. Phillips Petroleum Co. Geothermal Exploration Archaeological Reconnaissance Report. ARR 05-09-14 (CY-82). Modoc National Forest, Alturas.

_____. 1982. Union Oil Co. Geothermal Exploration Archaeological Reconnaissance Report. ARR 05-09-15 (CY-82).

_____. 1983. Cultural Resource Overview--Modoc National Forest.

Goddard, Dorothy M. 1984. An Archaeological Reconnaissance of the Wild Horse Timber Sale ARR 05-05-446. Klamath National Forest, Yreka.

Hardesty, Donald L. and Steven Fox. 1974. Archaeological Investigations in Northern California. Nevada Archaeological Survey, Research Paper No. 4. Reno.

Hopkins, Joseph W. III. 1984. Wild Horse Mountain Timber Sale: An evaluation of sites No. 05-05-57-367, 368, 381 and 403. MS on file Klamath National Forest, Yreka.

Jensen, Peter. 1983. Union Oil Co. Geothermal Exploration Archaeological Survey Report. ASR 05-09-363. Modoc National Forest, Alturas.

Johansen, John. 1981. Border Insect Salvage Timber Sale Archaeological Reconnaissance Report. ARR 05-09-23 (CY-81). Modoc National Forest, Alturas.

_____. 1981. Shotgun Insect Salvage Timber Sale Archaeological Reconnaissance Report. ARR 05-09-30 (CY-81). Modoc National Forest, Alturas.

Jones, R. 1983. Medicine Lake Water Quality Study 1982-1983, Modoc National Forest.

Kestin, J., 1980. Sourcebook on the production of electricity from geothermal energy. U.S. Dept. of Energy, Division of Geothermal Energy, Contract No. EY-76-S-4051.A00Z, 997 pp.

Kiester, F.P. 1981. Characteristics of winter roosts and populations of bald eagles in the Klamath Basin. MS Thesis, Oregon State Univ., Corvalis.

King, John. 1976. Yellowjacket Timber Sale Archaeological Reconnaissance Report. ARR 05-09-30 (CY-76). Modoc National Forest, Alturas.

_____. 1977. Black Mountain Prescribed Burn Archaeological Reconnaissance Report. ARR 05-09-03 (CY-77). Modoc National Forest, Alturas.

_____. 1977. Medicine Timber Sale Archaeological Reconnaissance Report. ARR 05-09-17 (CY-76). Modoc National Forest, Alturas.

Laudenslayer, W.F. 1982. California wildlife habitat relationships program - Northeast Interior Zone. Volume I - Introduction and species habitat relationships matrix. Forest Service - USDA, Region 5.

Leitner, P. 1978. An environmental overview of geothermal development: The Geysers-Calistoga KGRA. Volume 3. Noise, UCRL-52496, Lawrence Livermore Laboratory, University of California, Livermore, California 94550.

Nathenson, M. 1975. Physical factors determining the fraction of stored energy recoverable from hydrothermal convection systems and conduction-dominated areas. U.S. Geological Survey Open File Report 75-525. 35 pp.

National Forest Management Act (NFMA) 1976. Public Law 94-588, as amended.

Navarre, Gary. 1978. Medicine Lake Wood Cutting Area Archaeological Reconnaissance Report. ARR 05-09-11 (CY-79). Modoc National Forest, Alturas.

_____. 1980. Pokey Thin Timber Sale Archaeological Reconnaissance Report. ARR 05-09-48 (CY-80). Modoc National Forest, Alturas.

_____. 1980. Hawk Timber Sale Archaeological Reconnaissance Report. ARR 05-09-50 (CY-80). Modoc National Forest, Alturas.

_____. 1980. Medicine Lake Parking Area Archaeological Reconnaissance Report. ARR 05-09-51 (CY-80). Modoc National Forest, Alturas.

_____. 1980. Black Mountain Fuelbreak Archaeological Reconnaissance Report. ARR 05-09-58 (CY-80). Modoc National Forest, Alturas.

Olendorff, R.R., A.D. Miller and R.N. Lehman. 1981. Suggested practices for raptor protection on powerlines, the state of the art in 1981. Raptor Res. Rep. No. 11. 39 pp.

Ridgway, Nancy. 1983. Occidental Petroleum Co. Geothermal Exploration Archaeological Survey Report. ASR 05-09-370. Modoc National Forest, Alturas.

Rodgers, Thomas. 1983. Anadarko Geothermal Exploration Archaeological Survey Report. ASR 05-09-369. Modoc National Forest, Alturas.

Ross, M., H. Salwasser, D. Thayer and K. Shimamoto. 1982. Fish and wildlife habitat criteria for the Northeast Zone National Forests - mule deer. Forest Service - USDA, Region 5.

Roybal-Evans & Associates. 1982. Sites with Cultural Significance for the Upriver Bands of the Pit River Indian Tribe. Report prepared for Bureau of Land Management, Susanville District and U.S. Forest Service, Modoc National Forest.

SAI Engineers. 1979. Application for Certification, NCPA Geothermal Project No. 2, 110-MW Geothermal Power Plant, Geysers KGRA, Sonoma County, California. Prepared for Northern California Power Agency.

Salwasser, H. 1979. Ecology and management of the Devil's Garden Interstate deer herd and range. PhD. Thesis, Univ. of California, Berkeley.

Shannon, Peggy. 1978. Medicine Lake Toilet Installation Archaeological Reconnaissance Report. ARR 05-09-21 (CY-78). Modoc National Forest, Alturas.

Shimamoto, K. and T. Newman. 1982. Fish and wildlife habitat capability models and special habitat criteria for the Northeast Zone National Forests - bald eagle. Forest Service - USDA, Region 5.

Shimamoto, K. and D. Airola. 1982. Fish and wildlife habitat capability models and special habitat criteria for the Northeast Zone National Forests. Forest Service - USDA, Region 5.

Smith, R.L., and H.R. Shaw. 1975. Related geothermal systems, in White, D.E., and Williams, D.L., eds., Assessment of Geothermal Resources of the United States - 1975. U.S. Geological Survey Circular 726, 155 pp.

_____. 1979. Igneous-related geothermal systems, in Muffler, L.J.P., ed., Assessment of Geothermal Resources of the United States - 1978. U.S. Geological Survey Circular 790, 163 pp.

State of California. 1984. Labor Market Information - Modoc County. Climate Development Department. 69 pp.

Strojan, C.L., E.M. Romney. 1979. An environmental overview of geothermal development: The Mono-Long Valley KGRA. Laboratory of Nuclear Medicine and Radiation Biology, U.C.L.A., January.

Thomas, J.W. et al. 1979. Wildlife habitats in managed Forests in the Blue Mountains of Oregon and Washington. Forest Service - USDA, Agric. Handbook 553. 512 pp.

Toren, A.G. 1983. Lyons and Alcohol Timber Sale Archaeological Reconnaissance Report. ARR 05-09-47 (CY-80). Modoc National Forest, Alturas.

USDA Forest Service. 1973. National Forest Landscape Management, Volume 2, Chapter 1. Agricultural Handbook No. 462. 47 pp.

U.S. Environmental Protection Agency. 1971a. Noise from construction equipment and operations, building equipment, and home appliances. PB 206 717. Prepared by Bolt, Beranek, and Newman.

U.S. Environmental Protection Agency. 1971b. Transportation noise and noise from equipment powered by internal combustion engines. NTID 300.13.

U.S. Forest Service. 1981. Environmental assessment for geothermal leasing, Medicine Lake Planning Unit, Modoc, Klamath, and Shasta-Trinity National Forests, Pacific Southwest Region. May 20, 1980.

Weres, O., K. Tsao, and B. Wood. 1977. Resource, technology, and environment at The Geysers. Prepared for U.S. DOE by Lawrence Berkeley Lab, University of California, Berkeley, California.

Whitescarver. O.D. 1978. Mufflers to abate noise and particulate emissions from geothermal development operations. Proceedings, Geothermal Seminar '78, May 9-11, 1978, Lake County, California.

Wood Alice. 1976. Cupboard Timber Sale Archaeological Reconnaissance Report. ARR 05-09-14 (CY-76). Modoc National Forest, Alturas.

_____. 1976. High Hole Timber Sale Archaeological Reconnaissance.

# APPENDIX A

# ESTIMATION OF THE ELECTRICAL POTENTIAL OF THE GLASS MOUNTAIN AREA

## Estimation of the Electrical Potential of the Glass Mountain Area

This estimate of the electrical potential of the Glass Mountain area is made using information and methods published by Smith and Shaw (1975, 1979) and Brook and others (1979). The estimated electrical potential is based on the total thermal energy of the reservoir. A net electrical output is calculated from the total thermal energy after necessary reductions in the conversion from total heat, to available heat, to mechanical energy, to electricity. An analysis is possible because some reservoir data, which was not known when the United States Geological Survey (USGS) assessed the Medicine Lake (i.e. Glass Mountain) igneous system, is now available. A more simplified approach than the one presented by Brook and others (1979), however, must be used here, because detailed well and reservoir data does not exist.

Smith and Shaw (1975, 1979) have estimated the amount of thermal energy that remains in the ground (magma chamber, solidified pluton, and roof rocks) beneath the Glass Mountain area to be about $724 \times 10^{18}$ joules (1 joule = 1 watt-second). The thermal estimate is based on the assumption that a fixed volume of magma cooled from an initial 850°C temperature by conduction. The value is defined as the accessible resource base, and represents the energy contained in the crust between the surface and a depth of 10 km. The authors evaluated the area as an igneous-related geothermal system because evidence of a hydrothermal system was not available at that time. Industry drilling since 1982 suggests that a hydrothermal convection system exists.

The thermal energy contained in an associated hydrothermal system is only a part of the total energy of the igneous-related system. Brook and others (1979) show the percentages of total thermal energies in igneous-related systems that are contained in known associated hydrothermal systems. These are 1.0, 1.4, and 3.4 percent, respectively, for Valles caldera, New Mexico; Long Valley, California; and Yellowstone caldera, Wyoming. These percentages are defined as the accessible resource base, and represent the thermal energy contained in rock and fluid to a 3-km depth. Three kilometers is about the maximum drill-depth in hydrothermal systems. Brook and others used these percentages to estimate the possible thermal energy of undiscovered hydrothermal systems that were believed to be associated with other known igneous-related systems. Because reservoir data is not available for the Glass Mountain hydrothermal system, the same method is used here. The hydrothermal system is conservatively assumed to contain one percent of the total igneous-system thermal energy, or $7.24 \times 10^{18}$ joules.

To produce electricity, the thermal energy must first be converted to mechanical energy (work), and the mechanical energy is then used to generate electricity. Energy is lost during each of these conversions through waste heat rejection and mechanical losses in the power cycle. Brook and others (1979) term the maximum amount of work that can be obtained from a given amount of thermal energy as the available work ($W_A$), and the ratio of actual work to available work as the utilization factor ($n_U$). The authors present for hot-water systems (1979, fig. 5) a plot of the ratio of available work to reservoir thermal energy ($W_A/q_R$) versus mean reservoir temperature. The plot shows curves for two values of the depth to the middle of a reservoir.

To determine $W_A/q_R$ for the Glass Mountain area, the mean reservoir temperature and depth to the middle of the reservoir are needed. The mean reservoir temperature is calculated from the minimum, maximum, and most likely reservoir temperatures (Brook and others, 1979). The middle of the reservoir is the depth to the reservoir bottom minus one-half the reservoir thickness. The reservoir top is the shallowest depth at which 150°C temperatures are estimated to be found.

Several deep temperature gradient holes have been drilled in the Glass Mountain area. The well temperatures and gradient profiles were analyzed to estimate the maximum, minimum, and most likely reservoir temperatures. From these three values the mean reservoir temperature was calculated to be 193°C (C. Brook, oral commun., 1984). Also based on this temperature information the reservoir top is estimated to be about 1 km. The reservoir bottom is set at 3 km because this depth is about the limit of most geothermal production wells. The middle of the reservoir is, therefore, 2 km.

In figure 5 of Brook and others (1979), the ratio $W_A/q_R$ is 0.056 when the reservoir temperature is 193°C and the depth to the middle of the reservoir is 2 km. If $q_R$ in the hydrothermal system is $7.24 \times 10^{18}$ joules, then $W_A$ equals $40.544 \times 10^{16}$ joules.

Figure 6 of Brook and others (1979) presents the utilization factor ($n_U$) versus mean reservoir temperature for various power conversion technologies. A dual flash system is assumed for this analysis. Some heat energy is lost when the resource travels up the borehole. This amounts to about a 5°C drop in fluid temperature (K. Chan, oral commun., June, 1984). A wellhead fluid temperature may then be 188°C. At a 188°C fluid temperature, the utilization factor for a dual flash system is 0.36. A net $14.596 \times 10^{16}$ watt-seconds (joules) remains. This value is equivalent to about 154 megawatts (MW) over a 30-year period.

Smith and Shaw (1975) used the areal occurrence of silicic volcanic rocks to estimate the area of the Medicine Lake magma chamber to be about 74 $km^2$ (about 18,300 acres). The total thermal energy used in this analysis, and the 154 megawatt estimate are based on this size magma chamber. Geophysical evidence, however, lead Zucca and others (in press), and Iyer (oral commun., 1983) to estimate the magma chamber to be about 30 km in diameter, or about 706.5 $km^2$ (174,600 acres) in area. Because further thermal data does not exist, the 18,300 acres of "prime acres" are weighted heavier than the remaining Known Geothermal Resources Area (KGRA) acreage to estimate the total electrical generating potential at Glass Mountain.

The remaining Glass Mountain KGRA acres, excluding Lava Beds National Monument lands and the prime acres, total about 95,000. These acres are each weighted one-half and one-third the prime-acres megawatt value and are added to the prime-acres megawatt total. The two values are then averaged to obtain the estimated megawatt value. Table 1 shows the results of this procedure.

Table 1. Weighted megawatt values for prime acres and remaining acres of the Glass Mountain KGRA

| | Prime | Remaining (1/2 Wt.) | Remaining (1/3 Wt.) |
|---|---|---|---|
| Approx. acres | 18,300 | 95,000 | 95,000 |
| Estimated MW | 154 | - | - |
| MW/acre | 0.008415 | $\frac{0.008415}{2} = 0.004208$ | $\frac{0.008415}{3} = 0.002805$ |
| Weighted MW | - | 400 | 266 |
| Total MW (Prime + remaining) | | 554 | 420 |
| Total averaged MW ((1/2 Wt. + 1/3 Wt.)/2) | | 487 or approx. 500 | |

The total estimated electrical potential for a 30-year period is about 500 MW. This estimate does not include KGRA lands within Lava Beds National Monument. For purposes of this analysis, the value will be increased to 550 MW because the assumed size of power plants is 110 MW (2 55MW-units per power plant site).

# APPENDIX B

# GEOTHERMAL LEASE FORM

Form 3200–24
(May 1984)
(Formerly 3200–8 & 3200–21)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

FORM APPROVED
OBM NO. 1004-0038
Expires January 31, 1988

# OFFER TO LEASE AND LEASE FOR GEOTHERMAL RESOURCES

Serial No.

The undersigned (see reverse) offers to lease all or any of the lands in item 2 that are available for lease pursuant to the Geothermal Steam Act of 1970 (30 U.S.C. 1001-1025).

Read Instructions Before Completing

1. Name

Street

City, State, Zip Code

2. Surface managing agency if other than BLM: _____ Unit/Project _____

Legal description of land requested (segregate by public domain and acquired lands):

T. R. Meridian State County

Total acres applied for _____

Percent U.S. interest _____

Amount remitted: Filing fee $ _____ Rental fee $ _____ Total $ _____

DO NOT WRITE BELOW THIS LINE

3. Land included in lease:

T. R. Meridian State County

Total acres in lease _____

Rental retained $ _____

In accordance with the above offer, or the previously submitted competitive bid, this lease is issued granting the exclusive right to drill for, extract, produce, remove, utilize, sell, and dispose of all the geothermal resources in the lands described in item 3 together with the right to build and maintain necessary improvements thereupon, for a primary term of 10 years. Rights granted are subject to applicable laws, the terms, conditions, and attached stipulations of this lease, the Secretary of the Interior's regulations and formal orders in effect as of lease issuance and, when not inconsistent with lease rights granted or specific provisions of this lease, regulations and formal orders hereafter promulgated.

THE UNITED STATES OF AMERICA

Type of lease:

☐ Noncompetitive

☐ Competitive

☐ Other _____

by _____
(Signing Officer)

_____ _____
(Title) (Date)

EFFECTIVE DATE OF LEASE _____

4. (a) Undersigned certifies that:

(1) Offeror is a citizen of the United States, an association of such citizens, a municipality, or a corporation organized under the laws of the United States, any State or the District of Columbia. (2) All parties holding an interest in the offer are in compliance with 43 CFR 3200 and the authorizing Act. (3) Offeror's chargeable interests, direct and indirect, do not exceed that allowed under the Act, and (4) Offeror is not considered a minor under the laws of the State in which the lands covered by this offer are located.

(b) Undersigned agrees that signature to this offer constitutes acceptance of this lease, including all terms, conditions and stipulations of which offeror has been given notice, and any amendment or separate lease that may cover any land described in this offer open to lease application at the time this offer was filed but omitted for any reason from this lease. The offeror further agrees that this offer cannot be withdrawn, either in whole or part, unless the withdrawal is received by the BLM State Office before this lease, an amendment to this lease, or a separate lease, whichever covers the land described in the withdrawal, has been signed on behalf of the United States.

This offer will be rejected and will afford the offeror no priority if it is not properly completed and executed in accordance with the regulations, or if it is not accompanied by the required payments. Title 18 U.S.C. Sec. 1001 makes it a crime for any person knowingly and willfully to make to any Department or agency of the United States any false, fictitious or fraudulent statements or representations as to any matter within its jurisdiction.

Duly executed this _____ day of _____, 19 _____

_____
(Signature of Lessee or Attorney-in-fact)

## LEASE TERMS

Sec. 1. Rentals—Rentals shall be paid to proper office of lessor in advance of each lease year until there is production in commercial quantities from the leased lands. Annual rental rates per acre or fraction thereof are: $1 for noncompetitive leases and $2 for competitive leases.

If this lease or a portion thereof is committed to an approved cooperative or unit plan which includes a well capable of producing leased resources, and the plan contains a provision for allocation of production, royalties shall be paid on the production allocated to this lease. However, annual rentals shall continue to be due for those lands not within a participating area.

Failure to pay annual rental, if due, on or before the anniversary date of this lease (or next official working day if office is closed) shall automatically terminate this lease by operation of law. Rentals may be suspended by the Secretary upon a sufficient showing by lessee.

Sec. 2. Royalties—Royalties shall be paid to proper office of lessor. Royalties shall be computed in accordance with regulations and orders. Royalty rates on production are: 10 percent for steam, heat, or energy, 5 percent for byproducts, and 5 percent for demineralized water.

Lessor reserves the right to establish reasonable minimum values on production after giving lessee notice and an opportunity to be heard. Royalties shall be due and payable on the last day of the month following the month in which production occurred.

A minimum royalty shall be due for any lease year beginning on or after the commencement of production in commercial quantities in which royalty payments aggregate less than $2 per acre. Lessee shall pay such difference at the end of lease year. This minimum royalty may be waived, suspended, or reduced, and the above royalty rates may be reduced for all or portions of this lease if the Secretary determines that such action is necessary to encourage the greatest ultimate recovery of the leased resources, or is otherwise justified.

Sec. 3. Bonds—Lessee shall file and maintain any bond required under regulations.

Sec. 4. Diligence, rate of development, unitization, and drainage—Lessee shall perform diligent exploration as required by regulations and shall prevent unnecessary damage to, loss of, or waste of leased resources. Lessor reserves right to specify rates of development and production in the public interest and to require lessee to subscribe to a cooperative or unit plan, within 30 days of notice, if deemed necessary for proper development and operation of the area, field, or pool embracing these leased lands. Lessee shall drill and produce wells necessary to protect leased lands from drainage or pay compensatory royalty for drainage in amount determined by lessor.

Sec. 5. Documents, evidence, and inspection—Lessee shall file with proper office of lessor, not later than (30) days, after effective date thereof, any contract or evidence of other arrangement for the sale or disposal of production. At such times and in such form as lessor may prescribe, lessee shall furnish detailed statements showing amounts and quality of all products removed and sold, proceeds therefrom, and amount used for production purposes or unavoidably lost. Lessee shall be required to provide plats and schematic diagrams showing development work and improvements, and reports with respect to parties in interest, expenditures, and depreciation costs.

In the form prescribed by lessor, lessee shall keep a daily drilling record, a log, and complete information on well surveys and tests and keep a record of subsurface investigations and furnish copies to lessor when required. Lessee shall keep open at all reasonable times for inspection by any authorized officer of lessor, the leased premises and all wells, improvements, machinery, and fixtures thereon, and all books, accounts, maps, and records relative to operations, surveys, or investigations on or in the leased lands. Lessee shall maintain copies of all contracts, sales agreements, accounting records, and documentation such as billings, invoices, or similar documentation that support costs claimed as manufacturing, preparation, and/or transportation costs. All such records shall be maintained in lessee's accounting offices for future audit by lessor. Lessee shall maintain required records for 6 years after they are generated or, if an audit or investigation is underway, until released of the obligation to maintain such records by lessor.

During existence of this lease, information obtained under this section shall be closed to inspection by the public in accordance with the Freedom of Information Act (5 U.S.C. 552).

Sec. 6. Conduct of operations—Lessee shall conduct operations in a manner that minimizes adverse impacts to the land, air, and water, to cultural, biological, visual, and other resources, and to other land uses or users. Lessee shall take reasonable measures deemed necessary by lessor to accomplish the intent of this section. To the extent consistent with leased rights granted, such measures may include, but are not limited to, modification to siting or design of facilities, timing of operations, and specification of interim and final reclamation measures. Lessor reserves the right to continue existing uses and to authorize future uses upon or in the leased lands, including the approval of easements or rights-of-ways. Such uses shall be conditioned so as to prevent unnecessary or unreasonable interference with rights of lessees.

Prior to disturbing the surface of the leased lands, lessee shall contact lessor to be apprised of procedures to be followed and modifications or reclamation measures that may be necessary. Areas to be disturbed may require inventories or special studies to determine the extent of impacts to other resources. Lessee may be required to complete minor inventories or short term special studies under guidelines provided by lessor. If in the conduct of operations, threatened or endangered species, objects of historic or scientific interest, or substantial unanticipated environmental effects are observed, lessee shall immediately contact lessor. Lessee shall cease any operations that would result in the destruction of such species or objects.

Sec. 7. Production of byproducts—If the production, use, or conversion of geothermal resources from these leased lands is susceptible of producing a valuable byproduct or byproducts, including commercially demineralized water for beneficial uses in accordance with applicable State water laws, lessor may require substantial beneficial production or use thereof by lessee.

Sec. 8. Damages to property—Lessee shall pay lessor for damage to lessor's improvements, and shall save and hold lessor harmless from all claims for damage or harm to persons or property as a result of lease operations.

Sec. 9. Protection of diverse interests and equal opportunity—Lessee shall maintain a safe working environment in accordance with standard industry practices and take measures necessary to protect the health and safety of the public. Lessor reserves the right to ensure that production is sold at reasonable prices and to prevent monopoly.

Lessee shall comply with Executive Order No. 11246 of September 24, 1965, as amended, and regulations and relevant orders of the Secretary of Labor issued pursuant thereto. Neither lessee nor lessee's subcontractor shall maintain segregated facilities.

Sec. 10. Transfer of lease interests and relinquishment of lease—As required by regulations, lessee shall file with lessor, any assignment or other transfer of an interest in this lease. Lessee may relinquish this lease or any legal subdivision by filing in the proper office a written relinquishment, which shall be effective as of the date of filing, subject to the continued obligation of the lessee and surety to pay all accrued rentals and royalties.

Sec. 11. Delivery of premises—At such time as all or portions of this lease are returned to lessor, lessee shall place all wells in condition for suspension or abandonment, reclaim the land as specified by lessor, and within a reasonable period of time, remove equipment and improvements not deemed necessary by lessor for preservation of producible wells or continued protection of the environment.

Sec. 12. Proceedings in case of default—If lessee fails to comply with any provisions of this lease, and the noncompliance continues for 30 days after written notice thereof, this lease shall be subject to cancellation in accordance with the Act. However, if this lease includes land known to contain a well capable of production in commercial quantities, it may be cancelled only by judicial proceedings. This provision shall not be construed to prevent the exercise by lessor or any other legal and equitable remedy, including waiver of the default. Any such remedy or waiver shall not prevent later cancellation for the same default occurring at any other time.

Whenever the lessee fails to comply in a timely manner with any of the provisions of the Act, this lease, the regulations, or formal orders, and immediate action is required, the Lessor may enter on the leased lands and take measures deemed necessary to correct the failure at the expense of the Lessee.

Sec. 13. Heirs and successors-in-interest—Each obligation of this lease shall extend to and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assignees of the respective parties hereto.

# APPENDIX C

## PREVIOUS PUBLIC COMMENTS AND RESPONSE

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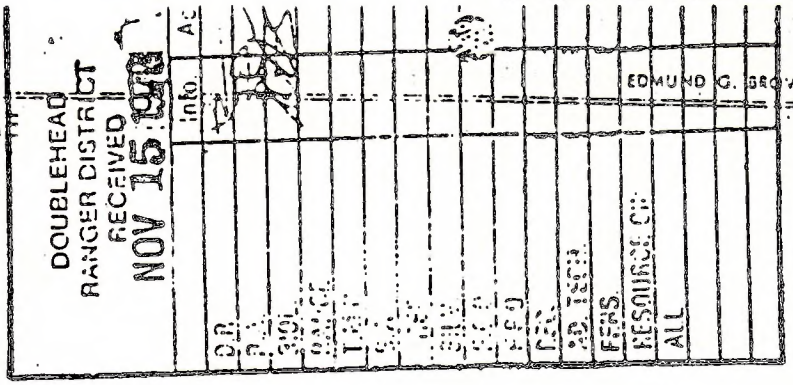
E OF CALIFORNIA—RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

EPARTMENT OF FISH AND GAME
.O. Box 1480
Redding, CA 96099
(916) 246-6511




November 14, 1979

Mr. Gene Grossman
District Ranger
Doublehead Ranger District
P.O. Box 818
Tulelake, CA 96134

Dear Mr. Grossman:

We have reviewed your letter of November 1, 1979, regarding the preparation of a project environmental assessment for geothermal exploration and development in the Medicine Lake Planning Unit.

We believe the Department's report entitled "The Fish and Wildlife Resources of the Klamath Basin, Lava Beds, Medicine Lake Highlands Planning Unit," August, 1976, will assist you in developing the fish and wildlife resources map of the area. In addition, the bald eagle winter roost sites and bald eagle nesting territories should be mapped.

The Bureau of Land Management office in Redding contracted a raptor study, which identified nesting locations of prairie falcons, Swainson's hawks, red-tailed hawks, kestrels, great horned owls and barn owls within the Medicine Lake Planning Unit, which should be included in the wildlife resource maps.

We believe that the critical wildlife areas should be identified and excluded from geothermal leases.

We believe a meeting would be helpful for our respective staffs to get together in the near future to more specifically delineate critical wildlife habitat areas that should be excluded from leasing.

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If you have any questions regarding our comments and would like to set up a meeting, please contact Tom Stone of our Redding office at 246-6544.

Very truly yours,

A.E. Naylor
Regional Manager
Region 1

cc: J.D. MacWilliams, Klamath National Forest

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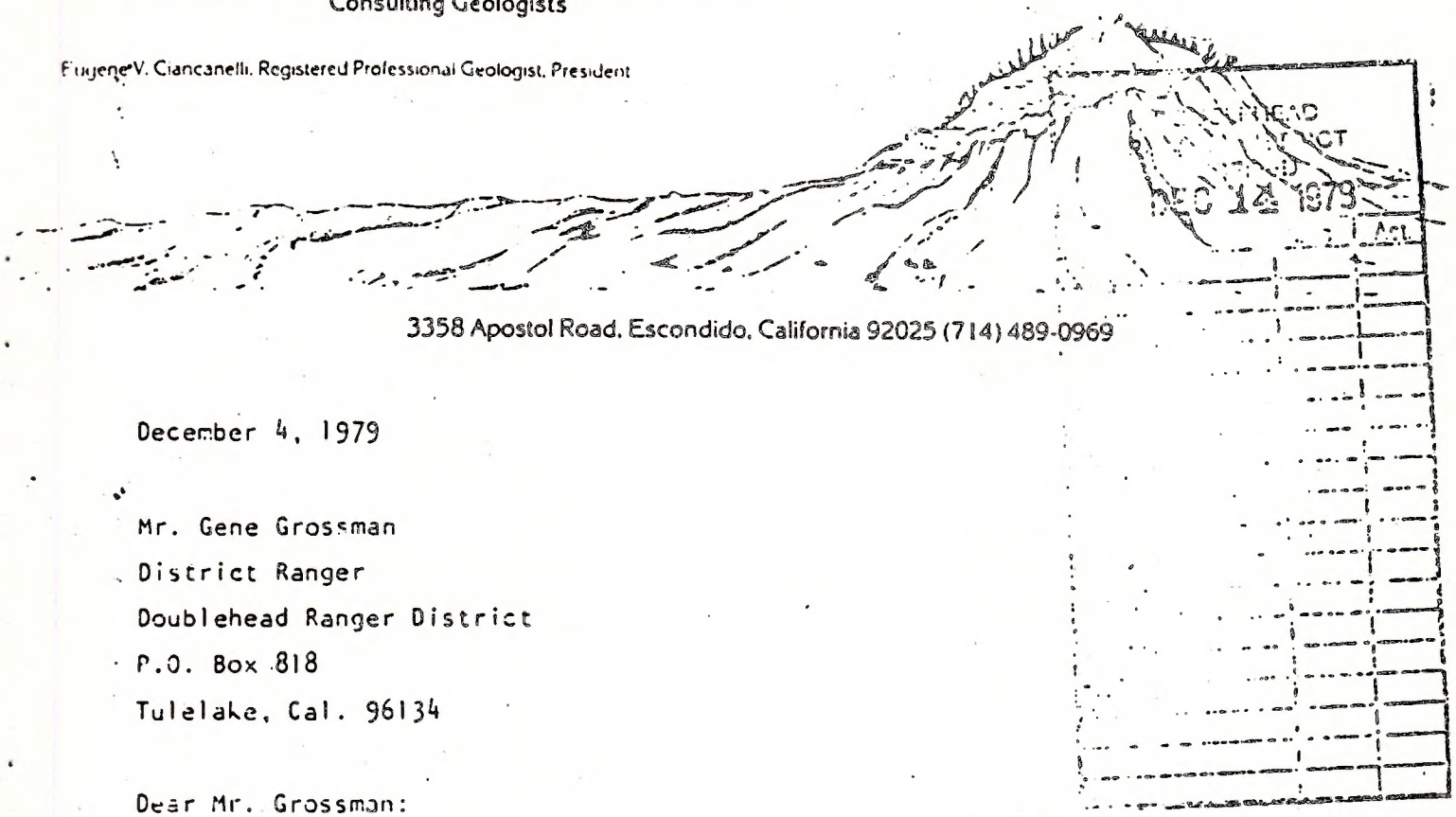
**Cascadia Exploration Corporation**
Consulting Geologists

Eugene V. Ciancanelli, Registered Professional Geologist, President

3358 Apostol Road, Escondido, California 92025 (714) 489-0969



DEC 14 1979

December 4, 1979

Mr. Gene Grossman
District Ranger
Doublehead Ranger District
P.O. Box 818
Tulelake, Cal. 96134

Dear Mr. Grossman:

I would like to respond to the Forest Service's request for comments on the environmental impacts of geothermal exploration and development within the Medicine Lake Planning Unit. For several years I have been engaged in detailed geologic investigation of the geothermal potential of the Medicine Lake Planning Unit. This work has included the preparation of a geologic map of the Medicine Lake volcano which required that I traverse the area and gain a detailed knowledge of the geology and environment. In addition to my knowledge of the Medicine Lake area, I also possess considerable experience in geothermal energy exploration and development. My background includes work on nearly every recognized geothermal reservoir capable of generating electric power in the western United States and I have consulted on geothermal projects in Canada, Japan and Guatemala.

There is a high probability that geothermal resources are present in the vicinity of the Medicine Lake volcano. If such resources are present it would be highly unlikely that they would occur beneath the entire Medicine Lake volcano. Geothermal reservoirs occupy relatively small areas generally on the order of 10 square miles or less. The World's largest known steam field, at the Geysers in Sonoma and Lake Counties California, will probably have an ultimate surface

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area of 50 square miles or less. The geology of geothermal reservoirs and the current level of production technology requires that the development of a geothermal field occur within the area immediately above the subsurface location of the reservoir. If large areas are set aside so that geothermal development can not occur or if development constraints are so sever as to make developement uneconomic or impractical then the possible reservoir which may be present can not be developed. The basic point of my argument is that if for example geothermal resources are present beneath 5% of the Medicine Lake volcano and if this area is not available to exploration and development then the geothermal resources of the area will not be developed.

I would suggest as a more rational approach to the evaluation of the Medicine Lake area's geothermal resources the following:

(1) Allow geothermal exploration across the entire Medicine Lake volcano excepting that certain features such as the glass flows, Medicine Lake and specific volcanic features be preserved not whole tracts of land. A single geothermal test well at the side of a glass flow for instance will not destroy or seriously impare the environment, but it will allow a determination of whether or not a geothermal reservoir is present. There is a sufficiently dense road network at Medicine Lake so that geothermal exploration of the entire structure can occur with considerably less impact to the environment then the current activities associated with logging, road building and development of the area by the Forest Service.

(2) If a geothermal reservoir is located then a detailed environmental impact statement can be prepared to assess the consequences of development. Furthermore having discovered a reservoir there will be a better understanding of the method of development necessary to exploit the reservoir and the physical and chemical characteristics of the reservoir. It will then be possible to rationally assess the impact of development and the potential benefits to society.

Within the Medicine Lake Planning Unit two existing mineral withdrawls and one proposed mineral withdrawl are established. I question the purpose and uniqueness of the Burnt Lava Flow Virgin Area as there are a number of virtually

identical areas in the Cascade Mountains. I agree that there is a necessity to preserve Medicine Lake, Little Glass Mountain and Paint Pot Crater, but caution that it is not necessary to set aside large areas to accomplish this objective.

The recent history of Federal land planning in the United States has been to set aside large tracts of land for various special purposes and to deny access for mineral and energy exploration and development. If there were unlimited energy and mineral resources and if these were uniformly distributed then such a policy would perhaps be resonable. Unfortunately as mineral and energy resources are consumed they become more difficult to find. Geologists have to explore for mineral and energy resources in the specific geologic environment where such resources occur. The current energy shortage which confronts our Nation should require that the geothermal energy potential of the Medicine Lake Planning Unit be thoroughly explored before a decision is made concerning the proper use for the lands in the Unit. I believe that the evaluation of the geothermal potential can best be accomplished by allowing private industry to explore the area using experience geothermal exploration geologists.

Sincerely,

Eugene V. Ciancanelli

Eugene V. Ciancanelli
Registered California Geologist #357

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REPUBLIC GEOTHERMAL, INC.
11823 EAST SLAUSON AVENUE, SUITE ONE
SANTA FE SPRINGS, CALIFORNIA 90670

TWX: 910.586.1696

(213) 945.3661

December 19, 1980

Mr. Thomas Neenan
Lands and Recreation Officer
Modoc National Forest
P.O. Box 611
Alturas, California 96101

Dear Mr. Neenan:

Republic Geothermal appreciates the opportunity to comment on the U.S. Forest Service Environmental Assessment for Geothermal Leasing in the Medicine Lake Planning Unit while it is still in its preliminary form. We have divided our comments into two parts, the first dealing with general issues, the second with specific comments on the EA. Republic also recognizes that our comments are based upon a review of the July 24, 1980 draft which may have undergone subsequent revisions unknown to us. If our comments have become moot, please accept our apologies.

General Comments

Although not explicitly stated, the EA appears to presume that geothermal operations will not progress beyond the exploration stage. This impression is conveyed by, among other things, repeated discussions of the potential envionmental impacts of preliminary geothermal exploration operations while no mention is ever made about the potential impacts of geothermal deep exploratory drilling, development or utilization operations. It is our understanding that since federal geothermal leases grant to the lessee the right to develop, produce and utilize the geothermal resources, the environmental document must, at least to some extent, expressly address the general impacts which could result from these subsequent operations. After leasing occurs, environmental documents are then prepared to address the specific impacts of each phase of operations as they are proposed.

Alternatively, we understand that certain federal geothermal leases are now being issued with conditional development stipulations which allow the Federal lessor to delay the environmental review and approval of any operations subsequent to exploration until such time as a specific proposal can be developed and submitted by the lessee. While Republic does not necessarily agree with this technique, we believe that

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if the Forest Service is contemplating this type of leasing decision in the Medicine Lake Planning Unit, this should be expressly stated and the proposed leasing conditions included in the EA. Republic believes that clarification of the Forest Service's intended leasing procedure is critically important to adequately commenting on the EA.

We are also concerned that the EA does not, in our opinion, adequately justify the aerial or temporal extent of the seasonal "no surface occupancy" (NSO) restrictions. Even after reviewing the final environmental statement on the Medicine Lake Land Management Plan we were unable to completely appreciate the need for restricting surface occupancy over such large areas and for such extended periods of time. A quick calculation shows that well over half of the unit will have seasonal NSO restrictions, most for six months or more, which would make ongoing geothermal operations very difficult and expensive to conduct. Republic has always been a company concerned about minimizing the impacts of its operations and is intending here only to state that the information presented in the EA and Land Management Plan do not appear to support the extent of the NSO restrictions. We would certainly be very willing to comply with any such restriction that in fact proves to be necessary or important. However, we do think it is very important that statements in the proposed special stipulations allow relief from the NSO restriction upon demonstration that any proposed activities will not cause significant adverse impacts within the restricted areas.

Specific Comments

We believe that the Known Geothermal Resource Area (KGRA) boundaries identified on the Planning Area map are incorrect. The following corrections to the boundaries identified on the map will reflect the current area designated as the Glass Mountain KGRA by the USGS:

(a) Delete Section 16, T43N, R3E, MDB & M.
(b) Add Section 4, T43N, R3E, MDB & M.

The Interdisciplinary Team recommended including in the leasing EA those lands outside of the Planning Unit for which the BLM has received geothermal lease applications. As such the following lands around the perimeter of the Planning Unit (as shown on page 2 and listed on page 3) should also be considered:

(a) SW corner of the SW corner of Section 36, T42N, R4E, MDB & M
(b) Sections 7 and 9, T41N, R4E, MDB & M
(c) SW Portions of Sections 18 and 19, T41N, R3E, MDB & M
(d) N Portion of Section 1, T43N, R2E, MDB & M
(e) Various Portions of Sections 3, 4, 10, 11, 14, 23, 27, 28, 29, 31, and 32, T44N, R3E, MDB & M

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The boundary adjustment area identified on the EA Planning Area Map shows extensively more area withdrawn than is reflected in the Forest Management Plan. This is particularly true for Sections 1 and 2, T44N, R3E, MDB & M; and Sections 1, 2, 3, 4, 5, 6, and 7, T44N, R4E, MDB & M. The rationale for these extensions is not identified, and the enlarged boundary adjustment study area is not justified in the EA.

Republic offers these comments with the desire to assist the Forest Service in developing a completely adequate environmental assessment, and we hope they will be accepted in that way. We remain very willing to assist in any way with this project and will be happy to discuss further any of our comments as you wish.

Respectfully,

Dwight L. Carey

Dwight L. Carey
Manager, Environmental Affairs

cc: Brad Reed - Doublehead Ranger District
Desmond Bain - Regional Forest Office

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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Conservation Division, MS-92
345 Middlefield Road
Menlo Park, CA 94025

MAR 25 1981

Mr. Lawrence K. Smith
Modoc National Forest
P.O. Box 611
Alturas, CA 96101

Dear Mr. Smith:

Thank you for sending us the March 3, 1981 draft of the Medicine Lake Geothermal Leasing EA. We are pleased that you have incorporated many of our earlier comments, especially comments designed to increase the flexibility of restricted leasing areas. Our specific comments on this draft follow:

1. Our office has undergone a reorganization. The title, "Area Geothermal Supervisor (AGS)" has been changed to "Deputy Conservation Manager for Geothermal," which may be abbreviated as "DCM, Geothermal." If the document is to be retyped, this change should be made throughout your document. If that is impractical, perhaps the title change could be noted early in the text or in an erratum.

2. We remain concerned that the EA contains insufficient information on existing Air Quality and Groundwater to alert bidders to the relative difficulties of meeting standards. We urge you to describe the Class I air quality status of the adjacent Lava Beds National Monument, and discuss how geothermal development could affect, and be affected by, the Class I status. Discussion of local meteorological conditions, especially wind patterns, would also be pertinent. A similar discussion of water quality is also needed. These additions need not be lengthy and might be accommodated in a few paragraphs.

If you have any questions related to these comments, please contact Joan Hopkins at (415) 323-8111, ext. 2848.

Sincerely,

William F. Isherwood
Acting Deputy Conservation Manager,
Geothermal

cc: Ted Hudson, District Geothermal Supervisor, Santa Rosa, CA

## RESPONSE TO PUBLIC COMMENTS

Written responses were received from the California Department of Fish and Game, and Cascadia Exploration Corporation, Republic Geothermal Inc., and U.S Geological Survey.

The Department of Fish and Game comments concerning wildlife protection were expanded during a joint meeting with the ID team. These concerns are met through the provisions of the Threatened and Endangered Species Act and the mitigating measure of restrictive leasing on critical wildlife habitat during the critical period of use.

Cascadia's and Republic's concern was undue limiting of exploration. This has been met by recommending leasing on as broad an area as possible within the restrictions of the Medicine Lake Land Management Plan.

The U.S. Geological Survey was concerned about the lack of detailed information regarding air quality and groundwater. Other than the general discussion in the Medicine Lake Planning Unit FES, little is known at this time about these resources. However, they will be examined and discussed in more detail in environmental documents prepared for subsequent steps in the overall exploration and development process.

Portions of the adjacent Lava Beds National Monument are classified as wilderness and are designated Class I relative to air quality standards. The remainder of the Monument is designated Class II, but is under consideration for Class I status. Future environmental documents will take this classification into account when discussing actual development that may impact the air quality of the area.

In addition, advertisements notifying the general public of the preparation of the EA and inviting comments were placed in the following newspapers in the area. There was no response.

Modoc County Record
Alturas, CA 96101

Mountain Echo
Fall River Mills, CA

Tulelake Reporter
Tulelake, CA 96134

Herald and News
Klamath Falls, OR 97601

Lake County Examiner
Lakeview, OR 97630

Hornet Buzz
Surprise Valley High School
Cedarville, CA 96101

Intermountain News
Burney, CA 96013

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# MAP 2 WILDLIFE

- AREAS AVAILABLE FOR LEASING
- ENVIRONMENTAL ASSESSMENT STUDY AREA BOUNDARY
- KGRA BOUNDARY
- NATIONAL FOREST AND MONUMENT BOUNDARIES
- BALD EAGLE WINTER ROOST
  Core Area
- BALD EAGLE NEST TERRITORY
  Core Area
- GOSHAWK NESTING TERRITORIES
- DEER WINTER RANGE
- DEER SUMMER RANGE
- DESIGNATED OLD GROWTH FOREST
- MEADOWS

T 45 N
T 44 N
T 44 N
T 43 N
T 43 N
T 42 N

R 2 E R 3 E
R 3 E R 4 E
R 4 E R 5 E

N

Glass Mountain Supplemented EA

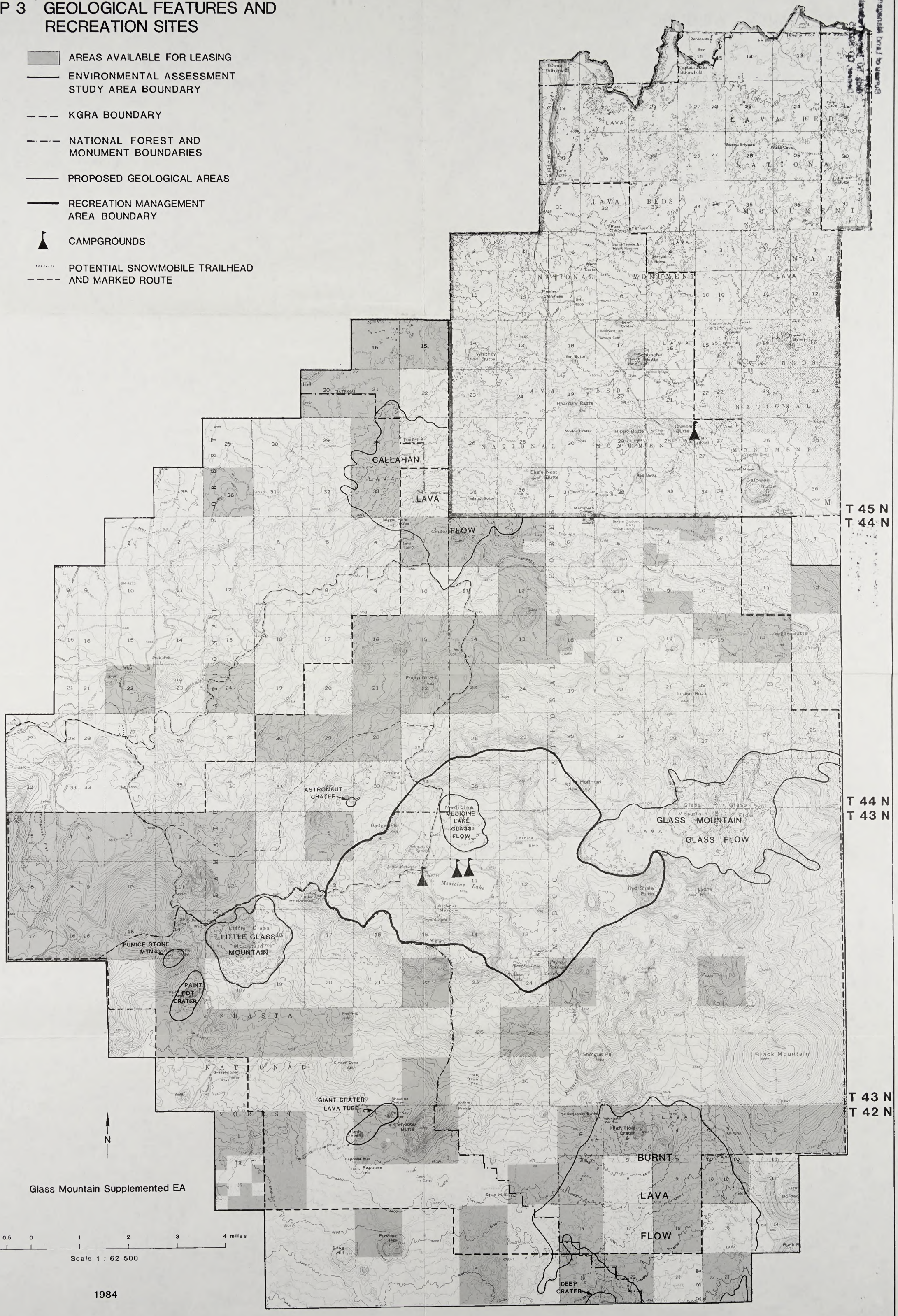
1 0.5 0 1 2 3 4 miles

Scale 1 : 62 500

1984

# MAP 3 GEOLOGICAL FEATURES AND RECREATION SITES

- AREAS AVAILABLE FOR LEASING
- ENVIRONMENTAL ASSESSMENT STUDY AREA BOUNDARY
- KGRA BOUNDARY
- NATIONAL FOREST AND MONUMENT BOUNDARIES
- PROPOSED GEOLOGICAL AREAS
- RECREATION MANAGEMENT AREA BOUNDARY
- CAMPGROUNDS
- POTENTIAL SNOWMOBILE TRAILHEAD AND MARKED ROUTE




N

Glass Mountain Supplemented EA

1 0.5 0 1 2 3 4 miles

Scale 1 : 62 500

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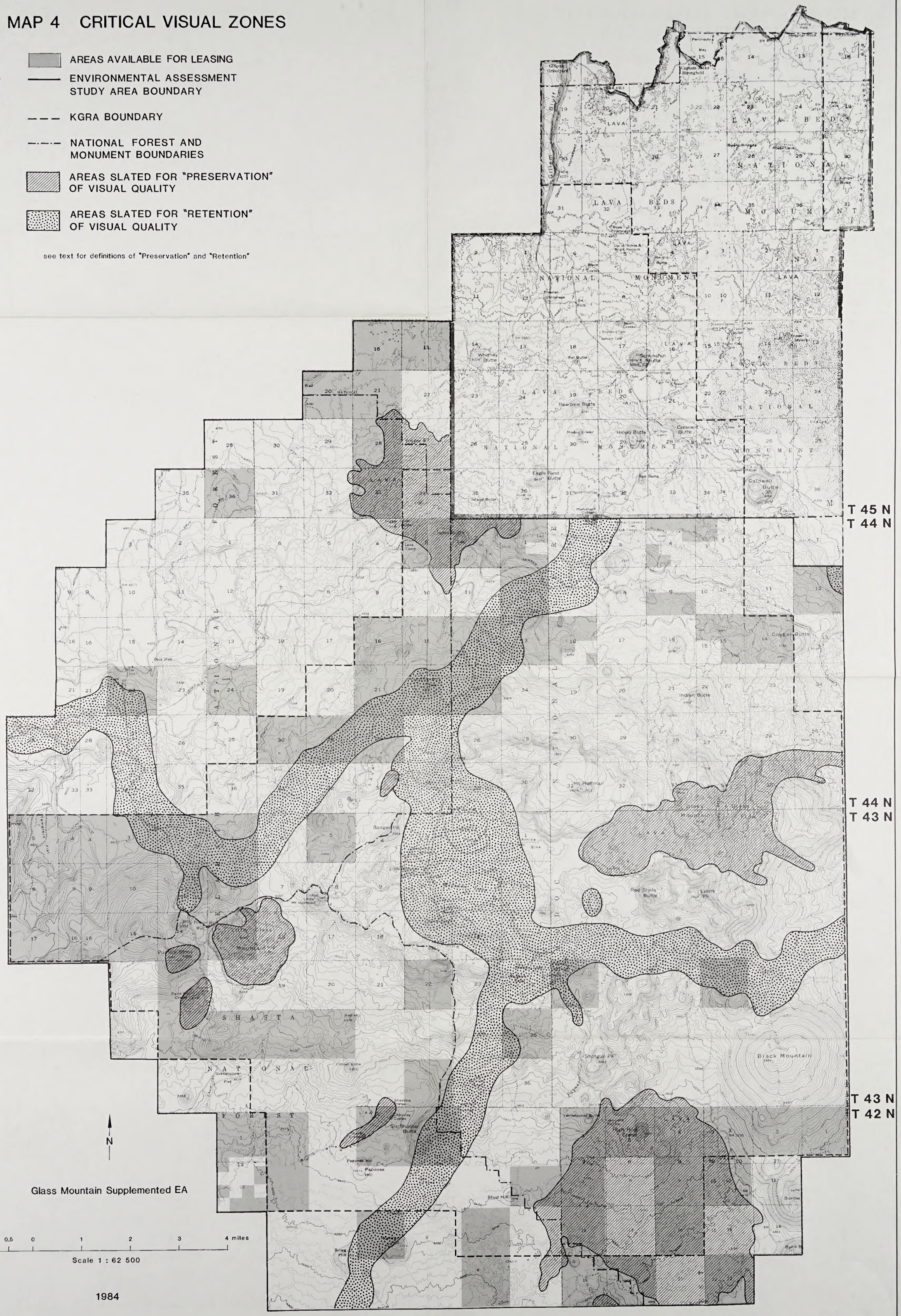
Denver, CO 80225

# MAP 4 CRITICAL VISUAL ZONES

- AREAS AVAILABLE FOR LEASING
- ENVIRONMENTAL ASSESSMENT STUDY AREA BOUNDARY
- KGRA BOUNDARY
- NATIONAL FOREST AND MONUMENT BOUNDARIES
- AREAS SLATED FOR "PRESERVATION" OF VISUAL QUALITY
- AREAS SLATED FOR "RETENTION" OF VISUAL QUALITY

see text for definitions of "Preservation" and "Retention"



# MAP 5 SPECIAL STIPULATIONS AND MITIGATING MEASURES

AREAS AVAILABLE FOR LEASING

ENVIRONMENTAL ASSESSMENT STUDY AREA BOUNDARY

KGRA BOUNDARY

NATIONAL FOREST AND MONUMENT BOUNDARIES

SPECIAL STIPULATION NO. 1 – PROTECTION OF SURFACE RESOURCES
(See page 13 of text)

Lava Beds National Monument Boundary Adjustment Area

Other Areas Pertaining To Special Stipulation No. 1

SPECIAL STIPULATION NO. 2 – PROTECTION OF WILDLIFE
(See pages 13 and 14 of text)

Areas With Seasonal Restrictions

Areas With Year-Round Restrictions

MITIGATING MEASURES (See page 52 of text)

Areas Of Visual Concerns

T 45 N
T 44 N

T 44 N
T 43 N

T 43 N
T 42 N

Glass Mountain Supplemented EA

1 0.5 0 1 2 3 4 miles

Scale 1 : 62 500

1984

R 2 E R 3 E

R 3 E R 4 E

R 4 E R 5 E